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THE TOTAL ASSESSMENT PROFILE VOLUME I

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SUMMARY

The traditional benefit-cost analysis is based on a static and exceedingly idealized economic theory ill-fitted to account for a multitude of economic, social and political interactions over time and space in a political and geographic setting. This static traditional economic theory ignores demographic dynamics, technological progress and institutional changes as well as the various limits to economic activity and its growth induced by various finite natural resources. The long-run effects of fiscal policy and public programs can be expected to be reflected over time and a geographical space not just in a local region, but eventually globally. Such effects cannot be analyzed just in terms of short-run static exchange market mechanisms typically assumed for traditional economic analysis.

It has been suggested that the impacts of public projects can occur in several dimensions, many of which cannot be accounted for in terms of the traditional benefit-cost analysis. This in turn suggests that the assessment of the public projects must include all the relevant and important institutional, social and political dimensions affecting and impacting a society outside of the realm of a short-run exchange market oriented economics. An assessment profile for the evaluation of a public project can be expected to consist of factors and measures not necessarily reducible to any meaningful monetary terms. A way of developing a Total Assessment Profile for the purposes of evaluating public projects is the subject of this report.

This report provides the mechanism by which more information can be obtained in the creation of a more complete benefit-cost picture. In the proposed procedure, the concept of a social space is used as a basis for clustering people with similar social and demographic backgrounds. Since people with similar social backgrounds, ability to participate in the goods and services of the society, values, and perceptual/attitudinal/and motivational characteristics, tend to share common living areas, the new methodology proposes to utilize this information in determining the location and relative size of various human groups. This is accomplished through the "comparative value matrix" by assessing the relative impact of a new technological innovation on the various human groupings.

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I. INTRODUCTION

In recent years, forecasting and predictive evaluation of technology has rapidly developed into a discipline of significant importance. Government agencies are now required to provide social, political, and environmental impact statements in conjunction with their economic evaluation and justifications of present and future research programs. They have as a matter of course, discovered basic inadequacies and limitations of the traditional benefit-cost methodologies and the respective fundamental limitations of the assumptions and concepts of the traditional classical economic theory.

The early work in technology assessment and evaluation rests primarily on a traditional benefit cost or cost effectiveness infrastructure. The increasing demand for such assessments and evaluations reflect a need to include both the basic economic interactions and impacts, as well as, a greater and more relevant recognition of the societal costs and benefits. Presently, the methodologies for assessing the social impact of new technologies are inappropriate for large scale use and general applications, unable to cope with long range effects and with a dynamic model of the society.

This study presents an overview of a new methodology developed by a research team at The University of Toledo under contract to the National Aeronautics and Space Administration. The methodology is intended to provide a means of assessing the social, political, environmental, demographic and economic impacts associated with the development and implementation of new technology. The methodology presented in this study recognizes the fundamental limitations of the economic theory and respective methods of the traditional benefit-cost approaches. Further, it augments the traditional managerial and engineering economics with social, political, and environmental considerations that can be impacted upon by a new technology.

The position taken in this report is based on the rationale that public policy and its component, economic policy, must be viewed in the framework of the total political and socio-economic system. It assumes that public policy cannot be removed from the structure of power politics which is derived from the ability to control and utilize cultural, economic and militaristic means of power. The political system consists of interest groups in an interactional environment of negotiations and bargaining. The results of such transactions leads to a more or less stable consensus expressed, among other things, as public policy (e.g. national defense and national security, national growth policies, etc.).

Normally, the components of public policy reflect social, political and economic dimensions that are mutually interdependent as they compete for the same resources or complement one another. It is for this reason that a "purely economic theoretic" perspective in technology assessment is inadequate in defining the total impacts upon a society. Limiting,

impact analyses, to market economic considerations and the respective theory of value and price creates a structure which is incapable of satisfactorily coping with those public goods that have no market precedent. This is particularly true in modern societies subjected to dynamic population, technological, and institutional changes.

It is our contention that an assessment of a public project must be operationally meaningful and include the following:

- it should be applicable in a given social, political, and economic setting;
- it should reflect a preference ordering measurably reflected by the society where it is to be applied.
- it should be valid and reliable so that prediction both for the present and future responses of the impacted society may be defined.
- it should be sufficiently simple and cost effective to aid in program selection, management and planning.

The assessment methodology must also be adaptive and have a clear empirical foundation. The empirical infrastructure is required, for it is through this component, that societal preferences are defined, while constraints of a normative nature are applied.

As noted, the methodology proposed in this report, is an extension of the traditional cost benefit analysis approach. Since World War II a dichotomous structure has existed in economics with the Neo-Keynesian macro-economic theory defined primarily within the context of "policy science", while on the other hand, the traditional micro-economic theory has provided the base for the "operational sciences". It has been through the introduction of this "operational" wing that the major theory for benefit-cost analysis has been derived. Unfortunately the polarization of economics into these two schools has necessitated the generation of a bridge so that planning processes may have a program effectiveness component and still reflect public policy. The inability of contemporary economic models to bridge this gap provides the stimulus for the methodology presented in this study.

The question posed is based on the need to develop a benefit cost evaluation that defines the perceived socio-economic and political impacts. In other words, a method for assessing a program's effectiveness in relation to public policy. This necessitates the augmentation of traditional benefit cost analysis with a set of possibly non-economic factors and considerations, such as those relating to psychological, social, political and cultural factors over time and space. These elements have not normally been explicitly included in contemporary economic theories.

It is obvious that a "purely economic" dimension will not suffice nor be necessarily a unique representation of a society's values, needs, desires, and behavior. Thus, it is suggested in this report, that a bridge be created between the polarized elements of macro and micro economic theory within the framework of a dynamic developmental economic base. In addition to the modifications in the economic dimension, it is proposed that a multidimensional perspective be applied that defines the orientation for new technology through the identification of societal needs and values. The methodology developed in this study is referred to as the Total Assessment Profile (T.A.P.). In essence, it reflects a market segmentation of society by its value structure. It suggests a need driven approach to technology innovation and assessment that isolates, not only the economic component, but, also the differential impacts on the social, political, and environmental subsystems.

The most serious limitation of traditional social impact analysis is associated with the weak theoretical structure of such studies and the generally subjective introduction of pertinent criteria. To overcome these limitations considerable theoretical developments are introduced in the report. Within these sections a theory of social action is derived and merged with contemporary concepts of human perception and behavior. The theory of social action defines the social system within a hierarchical and nested suprastructure with values, norms, role mobilization, and resource utilization patterns treated as respective stages. The preceding reflects a nested functional structure in which changes in the higher levels have ramifications on the lower levels of the hierarchy. The major premise of the theory is that a technological impact would be reflected at various levels of the components of social action. Thus, a realistic social analysis would define both the level of impact and the pertinent structural elements. In addition it should be recognized that various societal groups will have different values, norms, etc. Hence, a differential impact may be anticipated by various groups based on their perception of the technology's impact on their values. The total assessment profile attempts to segment the society into groups which represent a high degree of homogeneity of value preference. It then predicts how the technology will be perceived by these groups. When the technology has a positive value augmenting effect a benefit is derived, if the technology impacts negatively on the value structure a cost in the form of stress is generated. It should be noted, that T.A.P. does not attempt to have these groups assess the technology, but rather assesses the technology's impact on the groups value structure. This is an important departure, for it eliminates the need for the general population to assess technical and complex innovations. The innovation in a total assessment application is transformed from a technical construct to a common denominator by defining its value implications. It is the value implications which are assessed rather than the technology itself.

The implementation of the Total Assessment Profile is provided through the derivation of a comparative values experimental design. The basic concept of T.A.P. utilizes the viewpoint that individuals perceive social reality differently depending upon their ability to participate

in the goods and services of the society. Collections of individuals with similar perceptions are labeled phenotypes and can be readily identified through market segmenting procedures. The identification of phenotypic groups provides the base of evaluation through the "Comparative Value Matrix". Here the values of the phenotypes and the corresponding impact of the new technology on this values structure can be readily determined through the use of social areal analysis, coupled with multidimensional scaling techniques. The preceding evaluation is accomplished through the utilization of Maslow's hierarchical model of values.

A comparative component in the matrix is derived from the technology's sponsor. The sponsor of the new technology evaluates the innovation in respect to its impact on Maslow's Hierarchical Value Scale. Thus, the responsibility for the technical evaluation rests on the sponsor rather than the general public. The sponsor's scale of value impacts is then compared with the phenotypes value profile to define benefits (value augmentation) or cost (value subsidence).

The comparative value matrix provides valuable information pertaining to the size and consistency of the phenotype, their ability to participate in the goods and services as modified by the new technology and their influence in the decision making process. It provides a measure of public policy and those who support it as opposed to those who reject it. The Total Assessment Profile provides the base from which the sponsor of the new technology is able to evaluate social, political, environmental implications of the innovation on a society in addition to the relevant economic considerations.

This report has been subdivided into three major sections to illustrate the derivations and applicability of T.A.P.:

Section I provides a basic review of traditional benefit cost analysis, as well as identifying its most serious shortcomings. The section investigates the micro/macro dualism problem and the means of integration of these concepts for long range technological planning. A detailed critique of the limitations associated with both micro and macro economic models is included in this section.

The second part of the report provides a dual function. The initial stage provides the theoretical infra-structure for social impact analysis. The theory of social action is derived in this section through the consolidation of sociological theory and a behavioral theory of perception within a spatial temporal frame. The second part of this section involves the operationalization of the Total Assessment Profile. It illustrates the instrumentation and experimental design for implementing T.A.P. as well as, defining the structural character of the comparative values matrix for each phenotypic group.

The third section of the report provides an example of the Total Assessment Profile in the context of an early warning disaster satellite system. Due to limitations in the scope of the contract a complete application was not possible, however, the dynamics of key variables are illustrated in this section.

II. ECONOMICS IN PERSPECTIVE

1. INTRODUCTION

This section presents a preliminary survey on economic theory leading to the foundations of the benefit-cost analysis as it is known today. This survey is not intended to be a comprehensive theoretical analysis of economic theory but rather a general survey pointing out some basic limitations of the traditional concepts of economics in analyzing the worth of public projects. There is a large gap between direct costs and benefits and indirect costs and benefits simply because the traditional microeconomics is ill-fitted to handle social interactions except at a naive atomistic level. A variety of obvious social, economic and political interaction typifying modern dynamic societies with political demographic, technological and institutional processes must be treated as "externalities" or "distortions" or "pathological phenomena" in the context of the traditional microeconomic theory and its extensions into welfare economics. This unsatisfactory and unrealistic state of economic theory has been criticized by many notable economists; and it has lead to the question of the usefulness of benefit-cost analysis beyond being a mere exercise in futility. This survey looks at some points pro and con. Further, its purpose is to generate questions why and how welfare and benefit-cost considerations could be expanded beyond current economic theory in its present state of an apparently rather closed science. Being a preliminary survey, it is not intended to answer all of these questions. This task is delegated to subsequent sections of this report where we explore the development of an operationally meaningful assessment profile for the evaluation of public projects.

2. ECONOMIC FOUNDATIONS OF BENEFIT-COST ANALYSIS: A BRIEF SURVEY

Economics has never been a well defined discipline. Its perspectives and subject matter have shifted over time often with controversies, and it overlaps strongly with other disciplines such as history, political science, sociology, psychology and anthropology. Economics does deal with the manner in which people and society choose to use more or less limited resources for the accomplishment of alternative goal patterns. It includes also the study of unemployed resources [1,2].

Normative Economics is a study of how people and society should select the alternative goal patterns and then how they should choose the means to use the limited resources in order to reach these goals. Its nature is prescriptive and presupposes a commitment to a specific preference or value system of the people and the society [3, Chapter 1].

Descriptive and Predictive Economics is concerned with empirical studies on how people and society actually behave in selecting goals and ways to reach them, and how they actually use scarce resources to accomplish these ends. It is then hoped that if such empirical studies are

successful enough it would be possible to predict economic behavior under some specifiable future circumstances. In particular, descriptive and predictive economics is also concerned with the empirical studies on the actual behavior of people and society in asserting their values and preferences under various situations of choice [3, Chapter 1].

It should be noted that if normative economics be realistically feasible its foundations must rest greatly on the successful results of descriptive and predictive economics. A degree of relevance rests here on the empirical foundations of normative value systems.

One of the main objectives of economics is to construct a logical system of interrelationships enabling one to consistently account for various interrelated economic behavior such as production, consumption, investment, employment or unemployment of various resources, prices, inflation, growth of economic activity, and so on. The purpose is to find an effectively simple way to describe, analyze, explain and correlate various aspects and dimensions of economic behavior. A resulting systematic construct serving as a base for analysis is called economic model. Economic model is a map of interrelationships with specific objectives of use corresponding appropriately to its respective empirically surveyed landscape of actual economic behavior processes. Thus, economic models are caricatures of economic reality emphasizing certain prominent and essential features while totally ignoring some other seemingly unimportant details. It should be noted however, that a particular feature unimportant in one economic model may be very important in another economic model, being dictated by the very purpose of the particular model. A model exemplifies a goal oriented selective way of looking at the world. It relates to our needs to look at a "local" or a "global" system in a setting of a particular perspective. Economic models need not be, and typically are not restricted to any one specific set of constraints associated by some specific point of view or perspective [see reference 5, Chapter 1].

In the advent of the era of "general systems theory", economic models can be viewed as portrayals of subsystems in a hierarchy of increasingly general "global systems". As pointed out by Henderson and Quandt [1, p. 2], an economic model contains three sets of elements: (1) data playing the role of parameters given from outside the system, such as "given this consumer preference function", "given a specific technology", "given the marginal propensity to consume", etc.; (2) variables whose magnitudes are given within the system such as prices, interest rates, quantities, profits, etc.; and (3) specific behavioral assumptions such as "supply equals demand" by which the values of the variables become determined. Basically, then, economics is not a "closed hard science" but is about as soft as our attempts to understand basic human behavior in a "global system". When an economic model is expanded into a more general system level, some parameters assumed to be given from outside the system can be converted into variables determined within the system.

According to their specific objectives and purposes economic models can have, respectively, different structures. Some of these will be outlined now:

Microeconomics is the study of economic behavior of individual economic units such as individuals, households, firms and specific institutions. In microeconomics price formation in the framework of allocation of scarce resources to specific end uses plays conventionally the prominent role: individuals earn income by selling their "factors of production" such as labor or managerial services, to firms. Firms produce goods and services and sell them to individuals. Pricing of factors of production and economic goods (goods and services) results from such behavioral assumptions about these economic units as individuals' maximization of satisfaction from the goods purchased with limited income and firms' maximization of profits under the constraints of a given production technology [1]. The overall economic behavior of a society is then obtained by aggregating upward from the levels of individual economic units into a totality appropriately closed by accounting for all relevant interactions between all the individual economic units.

In the so-called "free market" economies the traditional microeconomic theory of perfect competition has greatly influenced and molded the normative attitudes of policy makers and planners, and thereby also the roots of the present day welfare economics including foundations of the benefit-cost principles. Historically, when Western societies shifted from medieval feudalistic and colonial mercantilist policies through French revolution and its diffused social transformations toward modern industrial capitalism and market economies there appeared several writers of "economic liberalism". In Scandinavia, Anders Chydenius reacts to mercantilist policies by his The National Gain expressing many of the ideas and principles later appearing in the writings of Adam Smith [6]. Smith's "An Inquiry into the Nature of the Wealth of Nations" has become the classical bible of economic liberalism [7]. Based on Ricardo and his successors the marginal utility school of microeconomic theory evolves through works of Jevons, Menger and Walras. The concept of diminishing marginal utility has been expressed by several people such as Bernoulli, Cramer, McCulloch, Say, Bailey, and Senior [7], and has remained as one of the important aspects of modern utility or preference theory. Jevons and the Austrian School and Walras generated the so-called general equilibrium theory of perfect competition. It is closed steady-state system "with a given technology", no mechanism for dynamics of growth (ignoring also effects of population dynamics), and in an equilibrium with no unemployed resources. Because of its strong impact on normative attitudes and economic "conventional wisdom" [8], it deserves further discussion.

A good discussion on the general equilibrium model is given in reference [1], chapters 4 and 5. There are several assumptions leading to this model:

1. There is a very large number of households or individuals, each having only an infinitesimal effect on the volume of the total demand for economic goods.
2. There are no externalities between the preference structures or behaviors of the individual consumers. For example, no neighborhood effects are allowed. Firms have no influence on consumer preferences.
3. Every consumer maximizes his utility with perfect information.
4. There is a very large number of firms, each having only an infinitesimal effect on the total volume of supply.
5. There are no externalities between firms or their production functions. For example, there can be no economies of joint technologies, no collusions, no technical imitations and so on.
6. Each product is homogeneous. For example, there can be no product differentiation of a product produced by different firms.
7. Each firm maximizes its own profit with perfect information.
8. There is a completely free exit or entry for firms into or from any particular commodity market.
9. Every market is cleared. There are no unemployed resources.
10. In the long run, every firm or entrepreneur earns zero profit.

This model is an atomistic "ideal gas theory" of economics. The atomistic units are individually non-interactive and very large in number. Their impact on the total aggregated supply and demand is infinitesimal so that they can have no control on these collectively aggregated totalities. Supply equals demand regardless of what an individual economic unit does. An individual economic unit has only an infinitesimal economic power. The "invisible hand" is a collective force, a natural law of large numbers. Thus one has a Newtonian mechanistic theory, a kinetic theory of ideal economic gas in an equilibrium of social temperature and social energy. This mechanistic model is allowed to expand or contract in an analogy to the ideal gas equation where volume, pressure and temperature are kept interrelated in a quasistatic manner. There is no built-in mechanism allowed to describe, for example growth as an internal process.

The impact of this "ideal gas theory of economic behavior" on welfare economics is profound. And benefit-cost theory is an important aspect of welfare economics. One can promote an ethical belief that the welfare of a society depends upon the levels of satisfaction achieved by all of its members or consumers. As pointed out by Henderson and Quandt [1, Chapter 7], the task of welfare economics would be greatly

simplified if it was possible to aggregate all the individual utility functions into a single total social welfare function. But if interpersonal utility comparisons are not possible, then this cannot be done. Therefore, any one particular welfare choice while benefiting some individuals would also have unfavorable effects on others. An important contribution to welfare economics and utility theory is given by Vilfredo Pareto (1848-1923) whose Cours d'Economie Politique at Lausanne (1896-7) has become classic. His contributions to the general equilibrium theory include the concept of Pareto Optimality: If an allocation is determined by specific consumption levels of all the consumers and by input and output levels of each and all the firms or producers, then this allocation is Pareto-optimal if the production and distribution activities cannot be reorganized to increase the utility of one or more individuals without decreasing the utility of other individuals [1, Chapter 7]. One should note that if someone's utility can be increased without decreasing the utility of anyone else, then the system has not yet reached its Pareto-optimality, and is thus yet Pareto-nonoptimal. Under appropriate assumptions the general equilibrium model of perfect competition is Pareto-optimal. Consequently, it has become the normative ideal for welfare economics as well as standard for benefit-sacrifice criteria [1].

In the world today the previously mentioned assumptions for micro-economic theory of perfect competition seem for most part unrealistic; not feasible in a world of increasing interdependences, specialization, technological growth, population dynamics, and institutions few in number but large in size. Externalities are more a rule than exception. Consumers influence consumers, firms influence firms, consumers influence firms and firms consumers. Respectively, microeconomics has been modified in several directions such as in the direction of various theories of imperfect competition e.g. monopoly and oligopolies, "game theories" of Cournot, von Stackelberg and von Neumann; in the direction of organismic and organization theories of firm as well as in the directions of institutional, psycho-social and socio-political attempts to describe and understand consumer and producer behavior in today's world. By and large, microeconomic theory has not been very successful in bridging the behavior of individual economic units into the behavior of the over-all economic society. One must seriously question its validity as a base of realistic and feasible welfare economics [see, for example 8].

Macroeconomics is a study of such broad aggregates as regional or national total consumption, production, employment of resources and income. In aggregates the behavior of economic units are averaged out into "trends", and many of the detailed effects of interactions may be either partially or totally cancelled out. One of the distinct aspects of macroeconomic theory is that the microeconomic individual price determination is assumed away whereby the relationship between the individual economic units and the aggregates is no more clear. In macroeconomic theory, then, the behavior of aggregates do not require necessarily a particular micro-economic interpretation of the behavior of individual economic units, in a distinct contrast to the general equilibrium model of perfect competition. While prices can play an important role in macro theories, their

determination is abstracted away from the level of the behavior of individual economic units. From the point of view of public policy, macroeconomic theories are important in relation to such welfare questions as the general level of employment, income generation and distribution, general price levels and inflation, balance of payments in international trade, growth rate of the economy and so on. Some typical tools of public policy are fiscal and monetary policies. Clearly, the impact of public programs on macroeconomic behavior is an important dimension of benefit-cost analysis.

While in microeconomics one starts at the level of individual economic units and then aggregates upwards, in macroeconomics one starts at the aggregated level and then deaggregates into some appropriate structural level. Examples of such structural deaggregation are interindustry input-output models, interregional input-output models and a variety of public-private sector models. All these are important in benefit-cost analysis. In this regard, the input-output method developed by Wassily W. Leontief [9] is now a classic example, and has been adopted by public policy planners in many parts of the world.

Macroeconomic models relate to public policy planning at more or less aggregated levels of social needs. Although many of the concepts of welfare economics are derived from the traditional microeconomics, their operational aspects are based on macroeconomics with its respective emphasis on the behavior of aggregated units of social entities. While the attempts to make microeconomics operationally relevant for public policy purposes has been relatively disappointing, the contributions of macroeconomics have been so far very much more fruitful. If one relies on a macroeconomic normative structure for the purposes of a public policy, then one must also develop a respective aggregated social income accounting scheme serving the purpose of a public policy management information system. A typical approach is to develop a national or regional appropriately structured macroeconomic model whose parameters and coefficients are estimated within the best available data from the income accounting information system in order to predict the best possible practical way the future behavior of the economy as defined by the model. The methodology used in this task of estimating the past and present events as defined by the model in order to anticipate, predict and forecast a set of "possible futures" involves various techniques of model building, probability, statistics, simulation, and so on. A term "econometrics" is used in this connection [10,11,12,13].

Macroeconomic models and their respective social income accounting schemes are not unique. A model is a goal oriented selective structure requiring, by its very nature of selective goal orientation, a biased and filtered set of information. This aspect should be recognized as a potential or actual limitation for the purposes of an innovative open public policy formulation.

Among important "quasi-static" and, perhaps, "short run equilibrium" models of macroeconomics this sort of aggregate economics develops

historically several "grand themes" [14,15,16,17,18]. Its origins can be traced into the pioneering work of Wicksell, Say, Walras and others. The so-called classical macroeconomics [14, chapter 3] assumes perfect capital markets and the Say's Law stating that supply always creates its own demand. Therefore, excess production and unemployment of resources would be impossible. Historically, the classical macroeconomic "model" is an outgrowth of many of the notions of Walrasian equilibrium model of perfect competition. Among other things, the Keynesian macroeconomic model [14,15,16,17] assumes that capital markets are not necessarily perfect and that Say's Law need not be satisfied in an equilibrium of economic activity. This latter model has an obvious attraction in relation to such long run persistent phenomena as the Great Depression, when over many years the American economy experienced a tremendous unemployment of resources in an apparent contradiction to the claims of Say's Law. In such circumstances, the nature of an economic model and its apparent power of explanation has a profound normative influence on public policy formulation. Typically, level of employment, stability of price level, avoidance of undesirable fluctuations in economic activity, and an adequate balance of payments in international trade are some of the public policy criteria for which these macroeconomic models provide a logical foundation. There are trade-offs between these criteria, and a particular combination must be achieved by a compromise procedure that supposedly generates an optimal combination dictated, say, by a political process.

There are several actual or potential advantages of aggregation in economic theory building. Some of these are as follows:

1. There are not wholly disaggregated models in economics anyways. Households and firms are really social, political and economic aggregates of individuals. They are organizations that could form organizations in some hierarchially higher levels. There can be "externalities" that characterize certain meaningful economic aggregate entities which, also, can be identified in some operationally meaningful way.
2. Aggregated economic models have relatively few variables that can be more or less identified and measured.
3. Aggregations, per se, have some positive virtues in relation to the emphasis on social activity in terms of group behavior. It emphasizes collective aspects of economic behavior.
4. One can develop for aggregated models accounting equations with control totals in an operationally meaningful way.
5. Aggregated models have, relatively speaking, an "effective simplicity".
6. While in the aggregated models externalities need not be assumed away, such models can be subjected to some operationally meaningful deaggregation.

7. The large number of variables in micromodels can be subject to considerable cancellation effects as aggregation takes place. In economic impact analysis aggregated models tend to emphasize total net impacts.

Some basic disadvantages of aggregation in economic model building are:

1. Important structural aspects of economic system and behavior can be washed away and totally lost in the aggregation process. For example, the behavior of a significant and powerful economic agent producing or initiating an avalanching economic impact may be lost and cannot be identified in an overtly aggregated social accounting system.
2. As the consequence of the above disadvantage, an overaggregated model may not provide effective and necessary guidance for a public policy.
3. Aggregated economic behavior does not necessarily reflect the desires and preferences or welfare of individuals or particular social groups. There is a problem of relating the structural needs and utilities of individuals into what may be loosely called "social welfare function".
4. In an overaggregated system "economic welfare" may turn out to be actually harmful in part to some individuals or groups, or, perhaps, to the whole society. Harmful components of GNP need be identified.
5. The relative operational success of aggregated economic models tends to make economic criteria overemphasized in the formation of public policy. Other potentially important social and political dimensions may be excluded or may not be recognized by policy makers in such a setting of an apparent operational success.
6. While aggregated economic models can be simple, they are not necessarily complete. For example, they may account for exchange market activities but may ignore several important activities - such as migration of people - important for long-run economic development.

At the time of Soviet revolution, the Marxian economic theory was the only truly aggregated economic model. It had the consumers' goods and producers' goods sectors. The producers' goods sector was divided into constant capital such as industrial processing equipment and buildings, variable capital or labor, and surplus value. The consumers' goods sector was divided into consumers goods capital consumption, labor, and consumers surplus [27]. In the Marxian "no-growth" equilibrium the

producers' surplus was equated to consumers' labor plus consumers capital goods consumption. But growth requires savings over and above this equilibrium level of surplus. These savings can be used to obtain capital, labor and capital consumption for an increased level of productive capacity. Keynes expands and modifies his model to include effects of money markets. While the Marxian economic theory becomes the normative standard for "socialist camps", Keynes in effect disputes the inevitability of Socialism in the form of Communist-ruled centrally planned economies [28] by providing a view of a "dual economy" where there is room for national economic planning. In this view a "public sector" complements and augments a "private sector" in a manner which does not imply the inevitable collapse of a Capitalistic economy. The normative aspects of the Keynesian theory fitted the situation arising from the Great Depression, a situation that defied the explanations of the former classical economic theories.

A strong normative emphasis on a particular economic theory tends to promote a behavior pattern that generates its own self-fulfilling prophesy. But a normative reference structure must be sufficiently relevant in order that the respective performance and results are feasible and realizable in fact. A realistic policy is an adaptive one subject to societal learning processes.

Although the short run macroeconomic equilibrium models may be related to some criteria of growth and economic development they do not provide internally any mechanisms to explain growth. Growth and economic development are very important dimensions of public policy. The traditional static equilibrium models provide only a sequence of snapshots or a time series of comparative statics to help policy makers.

Economic Growth and Development theories and models attempt to provide both endogenous as well as exogenous mechanisms in order to account and explain processes of economic growth and expansion. While many of the static models may be mainly exchange market oriented and may not account for many of the factors causing growth (for example, "given technology", "given population", "assuming no effects of migration of population", etc.), the economic development models attempt to become more inclusive of pertinent economic, social and political processes which may be recognized as important aspects of growth [19,20,21]. In particular, these models may include population dynamics, technological dynamics and the more usual effects of the cumulation of productive assets or capital cumulation or productive capacity expansion. These kinds of models can be very important in assessing both direct and induced long run effects of public policies. In particular an adequate growth rate is an important public policy parameter in relation to population growth rate in order to maintain or increase per capita welfare in the society. Growth models are becoming an increasingly important tool for long run planning of economic development, as pointed out by Tinbergen and Bos [5]. In their book Mathematical Models of Economic Growth they present a sequence of successively increasingly complex and structured models. Reference [21] provides an overview of growth models.

Space-Time Economic Development Models add considerable richness into economic development models by introducing geographic and spatial dimensions that can be, also, related to social and political barrier effects, i.e., effects that can be traditionally "non-economic" aspects of a society. The addition of the spatial dimension into economic dynamics also suggests the inclusion of institutional, demographic and technological aspects of socio-political behavior to expand economic models from the narrow exchange market models toward "total social accounting" models including the possibility of a "multi-dimensional" value system beyond the one-dimensional ones implied by the traditional value and price theory. Spatial Macroeconomic Development (SMED) is concerned with diffusion, propagation and growth of economic and social activity over space and time. Among other things, it deals with the problems of upper limits to spatial densities of social and economic activities and the impacts of such densities on the "quality of life" [27,30].

SMED models can be made to include endogenously population dynamics in a setting of a finite "mother earth". The space-time economic development models are interesting also in that they can be related into geo-strategic aspects of political power. There are several interesting questions relating to the identification of social, political and economic activities and their measurability for the purposes of a relevant accounting for the purposes of a public policy. Nevertheless, space and time remain as basic dimensions of human activity. Benefits and costs have dimensions of time and space, and so do social and political impacts. For a modern Benefit-Cost analysis the dimensions of time and space, both, are essential. Transportation, migration, growth-diffusion, etc. are space-time phenomena. They have the respective spatial and temporal streams of benefits and costs.

Economic Development Models with Limits to Growth represent an expanded Neo-Malthusian look at a finite world with some essential but finite resources. An eternal growth within finite confines is an impossibility. These models look not only at the Malthusian [23] processes where the population growth overruns its respective economic growth leading to per capita starvation but also at the ultimate limits to any uncontrolled progressive growth process in a finite setting. In this latter setting, there can be a rather sudden ultimate collapse due to some basic limiting factor such as unchecked growth of pollution, running out of space to live on, or running out of fertile land for food production. The limits to growth models are very important from the point of view of long run planning aspects of public policy [22,24]. As examples at this point of time, the so-called third world exhibits some near Malthusian characteristics, and the socio-political and economic characteristics of large metropolitan complexes point to upper limits of the feasible and stable spatial extent and density of economic and socio-political activity. In such settings the public policy "parameters" shift from the emphasis of growth into the areas of societal life cycle planning and quality of life. Respectively, the traditional economic benefit-cost criteria for public projects require extensions beyond criteria set by value precedents

of already established exchange market processes. This is a typical problem of a dual economy (private sector - public sector) system where one assumes that market prices do truly reflect the actual preferences of consumers and, thereby, at least through a political process, those of the society.

Currently there are efforts to develop a quality of life index which would be useful for public policy purposes, among them, for the purposes of selecting public projects. In a recent Institute for Social Research news letter [ISR Newsletter 2(1), Spring 1974] this index should include measures in the following areas to help federal officials: health, the quality of work, attitudes toward government, education, environmental quality, crime, leisure and recreation, living conditions, racial and minority group relations, and transportation. These kinds of attempts point out that the traditional economic measures may not suffice to provide adequate and necessary social preference criteria in choosing a public policy and the respective public projects. It further suggests that a multi-dimensional approach may be needed in order to profile out the relative desirabilities of alternative choices of public projects. In a dynamic world of technological progress, population changes, institutional shifts and influences of power politics there can be several factors affecting human preferences that have no prior testing or could have no testing at all in a market place. Therefore one must question the validity of reducing all preference criteria of public projects into pure monetary and pecuniary values. This concern can be related to a general inquiry to the nature of economic theory in relation to psychological, social, political and historic dimensions of human societies.

Political Economy, Institutional Economy, Social Economy and Economic History go far beyond the idealized confines of the traditional Neo-Classical Economic Theory. While this theory may be pleasing to the eye with its beautiful logical structure, it easily might give one the unrealistic notion that economics is a closed science. Nevertheless, most great economists warn us against this notion. For example, the great classic Vilfredo Pareto [25] emphasized the sociological aspects of political economy. His "social system" was not closed, "fully rational" and included political considerations of "elite" rule. There is a notion of "social utility", "economic-cultural" cycle, and assumptions on interdependences or externalities was a rule rather than exception. Pareto deals with rational and irrational behavior. He talks about a "residue" as an invariance associated with the irrational or "non-logical" behavior. This residue manifests human sentiments, impulses and attitudes, and is considered as the underlying element in multitudinous human activities. It is masked by logical or pseudo-logical "derivations" or rationalizations. A perception of a human social institution is such a derivation giving an apparently logical justification for non-logical behavior.

The father of American Institutional Economics is Thorstein Bunde Veblen [7, pp. 439-454]. He takes an approach of social psychology into

economics. His institutions are religious, aesthetic, literary and cultural complexes of ideas very much like the derivations of Pareto. These institutions appear as behavioral rationalizations through which he tries to understand economic, social and political behavior of people beyond the conventional veil of accepted normative economic theory. It is in terms of socio-political entities in a framework of power and countervailing power that John Kenneth Galbraith views economic dynamics. He is a modern exponent of institutional economics. He looks at the nature of industrial planning, which among other things, includes minimization of uncertainty and market influences. In particular, by successful planning the market can be superseded, it can be controlled by buyers and sellers, and he notes that a modern large corporation and the modern apparatus of socialist planning are but variant accommodations to the same need. Galbraith points out the massive unreality of the "perfect competitive" model. Pareto himself had already rejected the notion that "free competition" is the rule in his contemporary societies [8].

Oscar Morgenstern names the traditional attachment to the "perfect competitive model" as the Walras-Pareto fixation (which, really, is unfair to Pareto!). He says: "'Free Competition', now the center and starting point of economic theorizing, will be recognized as what it is: a pathological, limiting case of possible economic organization, millions of miles from any reality we have ever known through the ages [31]." A human society is better viewed as a system of interacting social and political units, including cooperative associations and highly important "externalities". By means of military, economic or cultural power each unit likes to gain power over the actions and minds, not only over its own members, but over other social and political institutions. Hence, economics is not really an "isolated science" but is really political economy. Among other things, it deals not only with pecuniary impacts but with social and political impacts.

A relevant approach to public policy and to the benefits and costs of the respective public programs requires a realistic approach. Quoting Gunnar Myrdal, "...problems in the social sciences - not only the practical ones about what ought to be done, but also the theoretical problems of ascertaining the facts and the relations among facts - cannot be rationally posited except in terms of definite, concretized and explicit value premises. The old and tenacious "welfare economics", which has been revived in recent decades, is in this view nothing but a metaphysical attempt at "objectification" of what cannot be objectified. In its very approach it represents a philosophical lag which hampers the adjustment of economics to the demands raised by events on the rapidly changing national and international scene. At the present time it is crucially important to bring valuations explicitly into social analysis and not to hide illogically behind the pretense of false objectivity [27, preface]."

3. BASIC CONCEPTS IN ECONOMICS AND THEIR LIMITATIONS

Economics deals with the general subject of how a society chooses to use scarce resources for alternative purposes. A basic purpose of an economic activity is to assure an adequate consumption of food, shelter, clothing, health care, services to maintain social order and individual protection from harm, and so on, just in order to maintain and sustain an individual and social existence in a given physical, social and political environment. As this environment changes, the requirements for these necessities for survival also will have to change. From the point of view of social and political impacts, the ability of a society to produce these threshold requirements for survival is extremely important. The life of an individual and a society is necessary before we can talk about the quality of this life. Therefore, the consumption and the respective production for consumption can be meaningfully divided into basic necessities and non-necessities often called "luxuries". These concepts are to be related into a particular physical, social, political, technological and cultural environment. The production and consumption of non-necessities or luxuries can add and typically does add to the quality of life of individuals and their society, although many "luxuries" may actually turn out to be harmful to the health and wealth of an individual or a society.

The consumption by an individual, economic unit or institution, or a society is defined as the flow of goods and services used up permanently. For a society, this rate of using up goods and services per unit time is called "final consumption" to upkeep a level of human life. In order that a society can exist and then maintain a certain level of quality of life it demands for consumption goods and services. This demand has a threshold level determined by the level of necessities. What happens above this level of basic survival of the consumption demand relates to some kind of a social value system not necessarily solely through the so-called "economic behavior" but through a variety of social and political processes. Further, this value system likely varies over time, from location to location, is subject to imperfect information and learning processes and depends on intersubjective interactions at various hierarchical levels of social organizations. As noted by Pareto [25], such a value system may have its "logical" ("rational") and "non-logical" ("irrational") aspects, and can be colored by human "rationalizations" associated with his perceptions of social institutions.

The "rational economic man" is defined in classical and neo-classical economic theory as a person with a "well-informed" utility function which he maximizes under the constraint of a given finite income. Operationally this concept has turned out to be rather disappointing in predicting actual individual consumer behavior. Normatively, it has become one of the main pillars of the Walras-Pareto fixation mentioned by Oscar Morgenstern [32]. A considerable effort has been directed in neo-classical

economic theory to save this concept of "rational economic man" with his "freedom of choice" and "consumer sovereignty". In contrast, it is quite interesting to note how practical business men requiring practical operatinality, look at consumer behavior in marketing. The strategies of apparently very successful advertising appeal to the "unconscious" and "illogical", impulsive aspects of consumers' minds. The image of a "rational economic man" is played with the full intentions to circumvent any rational behavior as an obstacle to a successful sale. From a point of view of a practical business man, consumers get in the long run what they "deserve", while in the short run there can be maladjustments. From the point of view of a classical economic theorist, a consumer can have a rather peculiar utility function which he, nevertheless, keeps maximizing. This seems a rather hard way to try to save an unoperational theory: consumers are rational because they do what they do.

Marketing people point out that at this time there is no really useful theory of buyer behavior in marketing, the concern is with how buyers do behave, not how they should behave [36, pp. 70-72]. Consumer behavior is characterized by needs or drives incorporating adaptive learning processes, colored by attitudes and beliefs generated by interactions with other people (externalities). The traditional microeconomic theory provides its rigorous theory of buyers choice, but the empirical research generated by it has not been very relevant to marketing needs. Where did the "old gospel" go wrong? It assumed fixed preference patterns or unchanging tastes for consumers, perfect knowledge of alternative choices, unchanging products, perfectly divisible products; it assumed no thresholds of perception and discrimination, no social or inter-individual interactions such as "neighborhood effects", no risks or uncertainties, and a static world. None of these assumptions are even "reasonable" in our contemporary world. Social interactions and group pressures do influence what the individual believes he perceives, and most people will from time to time turn to other people for information, judgments and evaluations.

In a social group setting individuals do acquire a selective attention, selective exposure and selective retention. Beliefs and attitudes acquired in a setting of a social organization represent a hierarchy above needs or perceptions. Social structure extracts out status, role, social satisfaction and thereby influence on preferences of an individual. A modern marketing executive [36,37,38,39] deals with social factors as an essential feature of consumer demand: culture, social class, role conflicts, values and beliefs, personality, life style, reference groups, personal influence, media effectiveness.... a host of factors intimately tied with social order and social interactions. There are numerous "externalities" negating the operational value of the old economic theory.

The assumption that consumers are sovereign and have a freedom of choice is not an economic nor a political fact. The fact is that consumers have been exploited numerous ways contrary to this assumption. To protect the consumer interests against outside exploitations,

consumerism has developed into a countervailing force in a system that did not in fact honor the principles of classical consumer behavior but rather exploited the fixation to this image. Consumerism emphasizes the right to safety, the right to be informed, the right to choose, and the right to be heard. Consumer protection and product liability push for individual, social, legal and economic accountability. But consumerism is a force in a dynamic and changing world, and, in a sense is a force for human rights.

At the survival threshold of basic necessities the consumer's choice reduces to that of a desperado: to be or not to be, that is the question. At this threshold the classical theory clearly fails. This is an unstable point of desperate deeds, revolutions, wars and transformations of societies, and so on. It is not a state belonging to a nice economic equilibrium situation. Yet such a critical threshold situation can occur in various conditions of calamity whether man-made or natural. It is a possible condition for the consideration in any contingent disaster planning. It is also a state that makes much of the "third world" socio-politically flammable.

The counterpart of consumption in the circular flow is production. Production activity converts various inputs or factors of production by adding use value to them in a process of conversion in order to generate useful outputs. The object of production is to provide for consumption needs or consumption demand. But in an interindustry input-output setting it also provides for "intermediate goods" e.g. semi-finished goods and production equipment. Production must supply for the demand to replace wear, tear and obsolescence of productive resources or must compensate the so-called "capital consumption". Further, it must supply for the expansion of the productive capacity to accommodate a growing population or a growing per capita consumption or both. More specifically, production is designed to supply demands for:

1. Consumption by people
 - a. in order to just sustain human life,
 - b. in order to increase the quality of human life beyond a mere level of existence,
 - c. in order to accommodate population growth, and
 - d. in order to provide human energy for labor, innovations, skills, needed for productive activities.
2. Consumption of productive assets due to
 - a. wear, tear, corrosion,
 - b. destruction of productive assets by natural or man-made forces, and
 - c. obsolescence of productive assets due to technological and institutional changes.

3. Investment in new productive assets and capacity in order to accommodate growth of a society, both, in population and in per capita economic activity and quality of life.
4. Exports from the society to the rest of the world. Imports from the rest of the world are produced elsewhere, and are thus subtracted from the society's production demand.

A production process is characterized by a production function. This function gives the quantitative relationship between the inputs or factors of production, and the outputs supplying for the demands listed above. In microeconomics a production function is assumed for a firm, whereas in macroeconomics it is assumed for the society, or - as in the case of input-output analysis - for an industry. In macroeconomics the factors of production are abstracted into "labor" and "capital". Industrialists and businessmen dealing with production and manufacturing enterprises know that there are several possible significant factors of production, some of which cannot be easily quantitized: labor and skills of various kinds and levels, managerial and leadership talent and ability to motivate people, technological innovation, social and organizational innovation, natural resources and raw materials, land and space, production equipment and process technology, air, water, transportation facilities, an organized socio-political community, and so on. Production efficiency is affected by a multitude of social, political and economic factors. Theories of organization, social psychology, political science, and sociology are examples of modern sciences interest to business operations.

In the classical microeconomic theory - as a counterpart of the "rational economic man consumer" - there is the concept of "rational business firm". It is a firm like a person maximizing profits in a very unreal world of perfect competition. In this process it is assumed the firm has all the relevant variables under control. It assumes that there is only one decision maker in the business organization, it assumes no "externalities" or "game playing" between firms, and that the firms have no influence on the tastes of consumer. It assumes that firms are really not political institutions after political power, but purely entities that want to make revenue as large as possible and costs as small as possible. That is, the firms want to maximize their pecuniary "cost-effectiveness" or maximize their pecuniary "benefit-cost ratio".

In today's world powerful firms are not simple profit maximizing institutions. They are typically powerful economic, social and political complex organizations. Rather than doing simple profit maximization, they can assure their survival and growth by carving themselves a sound market share which they protect by cutting costs down by cumulative experience and by pricing products low enough against their competition. In the American scene, these firms form "industries" where there is one predominant leader, few significant followers and, maybe, smaller firms with no significant market control. The leader takes a big section of the market (IBM, GM, etc.), the bigger followers divide the rest leaving for the remaining firms some dribbles. The firms are not only economic but social and political institutions in the Fortune 500 category. They

control the majority of industrial production processes [32]. In the world of corporate power there are games of competition and games of cooperation. Power is expanded through horizontal and vertical mergers, control of markets, and ultimately, influence on consumers and public institutions [8].

Considerable diversions from the Walras-Pareto fixation occur when one considers the work done on "imperfect competition". The assumption that a firm pursues maximum profits is an overt simplification. It is a simplification to assume that any one objective governs all the operations of a firm. The interest in the survival and growth of the firm goes beyond the criteria of maximum dividends to the stockholders. The "maximization" of profits is a process of trial and error in a dynamic setting of imperfect information. The firm's reaction to uncertainty is one of the main features of its behavior. A firm drives for growth in volume as an end in itself and not a mere means to maximum profit [33, pp. 90-96].

"The Theory of Firm" is, indeed, in a state of chaos. The real world still escapes models; explanations remain at an aggregated level. The problem is clearly difficult, but it must be questioned whether economics can remain an empirical science and continue to ignore the actual decision-making processes of real firms [34]. The classical microeconomic theory has become a sterile mechanistic exercise. In this exercise the peculiar social, political and cultural characteristics of consumers and producers are assumed away. What microeconomics needs is a return to an institutional perspective and a perspective of political economy. Since a mechanistic microeconomics underlies much of the traditional welfare economics, this too, will remain rather sterile. In particular, if benefit-cost analysis is based on these sterile assumptions its relevance is highly questionable [35].

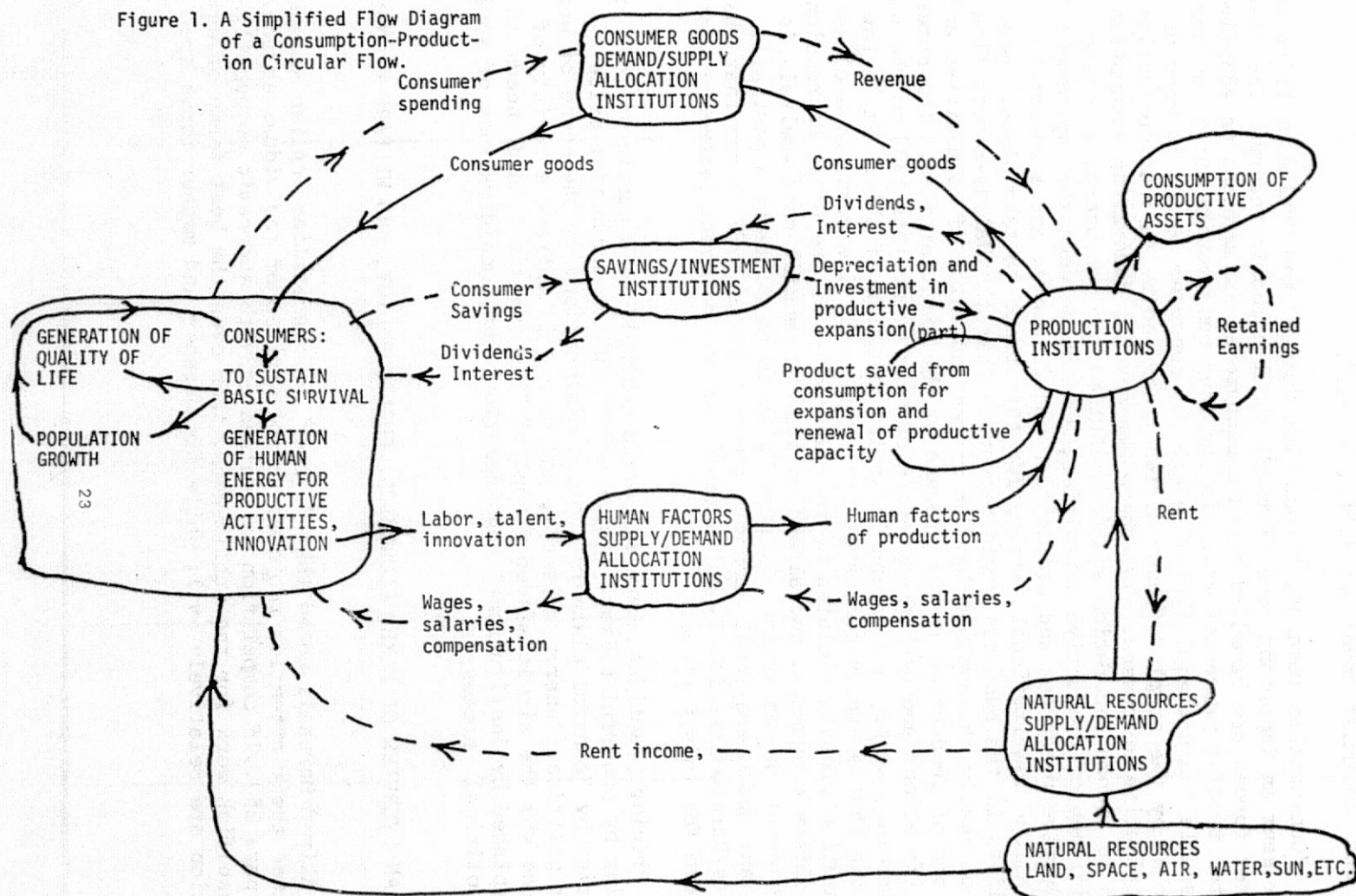
Consumption is necessary for survival, growth and quality of life. Consumption energizes individual and social action, makes human labor and innovation possible. In fact, consumption is necessary for the generation of factors of production: consumption is an input in order to produce factors of production. On the other hand, production generates goods and services that are consumed. Therefore, the consumption-production interaction system is a system of circular flows. This system must be efficient enough to compensate for irreversible losses or dissipation of "social energy" and it must provide a positive feedback if growth and increase in quality of life is to take place. Figure 1 illustrates the basic flow diagram of the "real goods" flows. In a simplified way it also illustrates the respective "money" flows. It should be emphasized again that biologically and socially to a point consumption is a productive activity and that amplification to provide positive feedback can arise in this process as well as in the production process itself. Therefore, there is an element of arbitrariness in defining what is consumption and what is production. The appropriate definition depends, among other things, on what social, political and institutional aspects are to be emphasized. For example, in the U.S.A.

income accounting system the emphasis is on exchange market activities. Therefore, washing machines, dryers, and other household productive equipment are really considered as consumer goods. If a household was considered as a firm selling services to its own use the accounting would look different. From the point of view of quality of life and survival, these household activities might suffice as necessary "self-sufficient" productive activity.

Figure 1 is a simplified flow diagram illustrating "product" and "money" flows. Consumer goods are allocated to the necessary basic survival, to accommodate population growth, to generate an increased quality of life, and to provide human energy for productive activities and innovation. Human factors of production are inputs to productive activities. In addition, natural resources are inputs to these processes. The productive activities generate consumption goods and services, replace wear and tear and depreciation of productive assets, and provide for expansion of these assets. There are the various basic institutions for allocation of consumer and producer goods and services, and there are "credit" institutions and institutions to handle the supply/demand problems of natural resources. Such institutions as those for consumer credit are not shown explicitly. It should be noted that the various supply/demand institutions combine various social, political and economic aspects not necessarily explained by the "Invisible Hand of Market Forces". For example, the labor supply/demand or "human factors" supply/demand involve such institutional aspects as labor unions, minimum wage laws, child labor laws, social security laws, technological training, and so on. The invisible hand has here many visible institutional dimensions. The supposedly impersonal market forces have many personal social, political and cultural dimensions, including special interests, political influence and power, manipulation of factors and product markets, and numerous other externalities not assumed within the Walras-Pareto fixation. The political and economic structures of society are closely interrelated: they are ultimately little more than aspects of the same organization.

While consumption and the respective production remain the key basic concepts of economics under the conditions of more or less scarce resources including the knowledge and innovation of how to live better and how to produce more efficiently for this purpose, there are not necessarily any unique ways of doing this job "the best way". The attempts to imagine such "best ways" lead to rigid normative views such as the Marxian view of the "socialist camp" and the neoclassical myth of a society imagining an existence in a world of a "perfect" or "free" competition. Such rigid views inhibit innovative experimentation and man's ability to discover new perspectives for looking at his world. The excessively centrally planned societies with the consequent inhibitions have problems of one kind while the decentralized and almost anarchistic "free market" societies would suffer from other types of problems. It might be more likely that a mixture of "pure ingredients" provides a better situation than any one pure ingredient by itself. Paul Samuelson notes: "The single most surprising development of our

Figure 1. A Simplified Flow Diagram of a Consumption-Production Circular Flow.



age has been the unpredicted vigor of the modern mixed (public and private sector) economy. The miracles of sustained growth in production and living standards have taken place in the second-level countries - Japan, Germany, Italy, France, Scandinavia, Western Europe generally - rather than in the most advanced countries like the United States and Canada or in the less developed countries of Latin America and Asia a market economy enriched by government planning and macroeconomic control could perform favorably in comparison to past epochs of both capitalist and communist development." [2, p. 712]..

"Consumption Demand", "Production Supply" and "Value or Price Theory" represent an important core of traditional economic theory. The so-called market forces are based on certain behavioral assumptions on adaptive barter trading processes which in the long run average out to an apparently stable "market equilibrium" where the consumer demand is more or less matched by the supply of commodities generated by various productive and distributive processes. But there are several underlying assumptions such as income generation and distribution for consumers, adequate efficiency of productive activities, a match between the employment of productive resources and consumption requirements, and a reasonably stable social and institutional setting for this trade to take place. Most realists in the business world recognize that the Walras-Pareto fixation is not really the explanation for prices and value of commodities and factors of production in the process of the circular flow. The numerous qualifications and doubts expressed by some economists [33] on the nature of pricing, supply and demand is an illustration of this. Say's Law stating that a supply generates its demand and vice versa is a classical assumption grossly violated by the experience of the Great Depression. If welfare economics, social accounting and benefit-cost analysis is to be relevant and effective, it must be based on at least a partially relevant and operational economic theory. It is safe to say that the Walras-Pareto fixation is not a realistic nor relevant reference ideal or norm for this purpose.

Pricing practices, wage and price controls by a public policy, price setting by powerful private sectors, "shadow" or accounting price policies by "central planners", price dislocations in the scene of world power politics ("energy crisis"), and so on, illustrate a variety of reasons why the simple minded gospel of "the invisible hand" needs to be replaced by institutional considerations and considerations of social and political processes.

4. AN OVERVIEW OF MIXED ECONOMIES, PUBLIC POLICY, AND WELFARE ECONOMICS

Alfred Marshall noted that "...perhaps the earlier English economists confined their attention too much to the motives of individual action.. [40, page 25].. If competition is contrasted with energetic cooperation in unselfish work for the public good, then even the best forms of competition are relatively evil; while its harsher and meaner forms are

hateful." Marshall notes that "the term 'competition' is not well suited to describe the special characteristics of industrial life in the modern age: "...Freedom of Industry and Enterprise,...., Economic Freedom,.... points in the right direction. Of course this deliberate and free choice may lead to a certain departure from individual freedom when co-operation or combination seems to offer the best route to the desired end [40, pp. 9-10]". Anders Chydenius, a notable economic liberal preceding Adam Smith notes "Petty prices allow themselves to meddle in all that they do not understand, solely according to their own or others' prejudices, or on the advice of corrupt ministers. They collect a great part of their subjects into certain groups and grant them advantages at the expense of the others, fortifying these advantages with privileges, whereby some are enabled in ease and idleness to achieve a superfluity, while the others end their days prematurely for want of work, and from starvation, or try to save their lives from destruction by emigrating [6, p. 39]." He sets forth the setting of a free competition leading to an equilibrium good for all: "A merchant who is entitled to trade freely enlarges his cares; he will be busy every moment turning over his goods with profit. If anyone tries to gain too much, he will get competitors, who will divide the gain and save citizens from barefaced robbery. Everyone must then be content with less profit on each commodity, but must instead turn it over much more frequently [6, p. 80]. The more simply a nation has followed Nature, the better off and more numerous it has become, the more evenly wealth is distributed, and the happier is its government; but, on the contrary, the more it has relied on artifice in trade and industry, the worse and unhappier is the State [6, p. 33]."

Natural liberty, freedom of trade, "The Natural Law", the "Right in Nature", and the "Invisible Hand" are ideas of seventeenth and eighteenth century political and economic philosophy. Chydenius is apparently the first to go the whole way demanding the application of natural liberty to economics. Not only does liberty promote productivity but helps to achieve distribution of income and wealth so that "none is rich, but all have their adequate subsistence". The economic liberalism of Chydenius and his immediate successor Adam Smith did not account for the social and political impacts of the Industrial Revolution, "heartlessly sucking the lifeblood of the workers (Karl Marx)". The principle of Natural Law and Economic Freedom was applied as a reaction against the regulated Mercantile Systems. Tampering with Natural Law was harmful, and the role of public policy was not to meddle with free trade but to protect it. The social control of "free enterprise" was viewed as an undesirable function. There was no need for such control as the "free enterprise" system was thought to be self-regulatory or regulated by a Natural Law and its Invisible Hand (Adam Smith). The Walras-Pareto equilibrium model is the illustration of this self-regulatory process. If left alone, everything would take care of itself. If tampered with by social and political interventions the result would be some undesirable dislocation. Such was the gospel (and still is) as the mankind penetrated into the era of Industrial Revolution.

Social Control of Business [41] is a trend of the day: The contemporary world is in the midst of a revolution which is transforming the character of business, the economic life and economic relations of every citizen, and the powers and responsibilities of the community toward business and of business toward community. Technological and social forces, the impacts of Industrial Revolution and science on society, have changed the old setting. The control of railroads and of public utilities, the trust movement and anti-trust laws, conservation, the Federal Reserve system, vast developments in labor legislation, social insurance, minimum wage laws and the compulsory arbitration of industrial disputes, pure-food laws and the growing control of public health, prohibition, control over markets and marketing, enlarged control over immigration and international trade, city planning and zoning, and municipal control of municipal growth, health insurance, the control of business cycle and of unemployment, and the insertion of social control within the structure of industry itself are examples of this trend of social control of business.

This many-sided movement toward control of business is mainly the result of three things: organized large scale production, growth of democracy, and the growth of science Business is bargaining; buying and selling, and producing goods and services for sale. Business is bargaining; buying and selling, and producing goods and services for sale. Business is the struggle for wealth. Business is the system of social cooperation by mutual exchange: it is not charity or benevolence, it is not play but work; a means to an end rather than end in itself [41, Chapter I].

In the setting of the classical free enterprise concept, the basic question relates to: Free from what? ... Free to do what? This, again, relates to what is desirable from the point of view of an individual and what is desirable from the point of view of a society at any point of time and location in a cultural process called human civilization. Among other things observed in the course of human history, motivation by self-gain and the consequent effectiveness of decentralized decision making are potential or actual moving forces against a background of a reasonable and workable setting of some collective goals and harmony. Human survival is not just an individual but also a collective concept requiring respective individualistic and collective considerations in a setting of a workable "social contract". It is in a setting of social norms and constraints that an individual sets his goals of self-interest. It could be conceived as a system of interactions where an individual and a society find their mutual workability as a desirable compromise solution over time and space.

In a contrast to the individualistic self-gain and the respective highly decentralized decision making processes one could consider a highly centralized planning and decision making process with its typical bureaucratic structure and inertia. Being stiff and sluggish, and full of formalistic rituals and void of individualistic motivation, such systems lack sensitivity toward effective productivity, adaptability

to changing circumstances and opportunities, and tend to stifle innovativeness and strangle down the ability to view a society from a multitude of different perspectives. The rigid mercantilistic policies in past and the rigid centralized planning societies of today exhibit these characteristics. It is only reasonable to assume that there is a relatively effective combination between the extremes of an almost anarchistically free exploitation for individual self-gain on one hand, and the rigid and compelling bureaucracy of a highly conformist and centrally planned society on the other hand. Quoting Samuelson [2, p. 44], "Democracies are not satisfied with the answers to WHAT, HOW and FOR WHOM given by a completely unrestrained market system. Such a system ... might dictate that some people starve ... while others get inadequate or excessive incomes.... Therefore the citizenry through their government step in with expenditure to supplement the real or money incomes of some individuals. More than this, government provides certain indispensable public services (public goods) without which community life would be unthinkable and which by their nature cannot appropriately be left to private enterprises" (because they do not care to do this and/or cannot do this or would lead them to a one-sided monopolistic power position in the society).

In a mixed dual economy there is a powerful public sector strong enough to augment an appropriate public policy and a social control of business upon the private sector in order to maintain a reasonable level of social coherence and a general direction toward overall societal goals generated through a political process. The following criteria are suggested for a "good system" of social control:

1. It must be democratic.
2. It should know what it wants.
3. It must be powerful enough to make an unwilling minority obey the will of majority.
4. It must be efficient while at the same time not to destroy the efficiency of the entity that it regulates.
5. It must "economize coercion".
6. It must utilize all the strongest and most persistent motives of human nature.
7. The duties imposed must be simple enough to be understood.
8. Controls must be guided by experience or be wisely experimental.
9. It must be adaptable.
10. It must be farseeing.
11. It must be capable of progressively raising the level of mankind [41, pp. 16-17].

It is basically in a democratic system where the dignity and freedom of individuals are preserved as much as possible within the concomitant necessary social controls.

Public policy and its component, the economic policy, must be viewed in the framework of total political and socio-economic system. In particular, it cannot be divorced from the structure of a general setting of power politics, whose main dimensions can be thought to be cultural, economic and militaristic (police power) means of power. Broadly speaking, political power refers to the ability of an individual or a group of individuals to affect the minds and actions of people in the direction of the interests of this individual or group of individuals in a setting of mutual interactions. A political system consists of a variety of interest groups in an interaction of give and take and gaming. The results of such give and take and gaming may be a more or less stable consensus expressed, among other things, as public policy. Some typical items covered in public policy are:

- National defense and national security
- Level of employment of labor force
- Patterns of growth of GNP and per capita GNP
- Maintenance of price levels and control of inflation
- Balance of payments and control of international trade
- Maintenance of an acceptable income distribution
- Control and development of energy resources
- Production and distribution of food, agricultural production
- Control of interstate commerce
- Control of monopolies and trusts; antitrust criteria and control
- Control of public utilities
- Control and development of communications
- Conservation of nature resources
- Environmental control
- Food and drug control
- Elimination of urban plight and poverty; urban renewal
- Control and protection of monetary, banking and security
exchange systems
- Stabilization of economic activity and control of recessions
- Control of immigration and population patterns
- Subsidy and control of technological progress, research and
development
- Control over racial and ethnic discrimination
- Subsidy to structurally affected industries and business
- Provision of educational opportunities and resources; man-
power training
- Rural electrification, irrigation and soil conservation
- Consumer protection
- Health insurance and protection
- Social security and pensions
- Protection of voting rights
- Control of crime
- Provision of public work programs for unemployed

Preventive and remedial resources for natural disasters
Public dimensions of transportation: highways, airports,
harbors, etc. urban transportation

This list could be expanded considerably. Typically, the items in such a list have their social, political and economic dimensions; and they are mutually interdependent, for example, as they compete for same resources or complement each other [2, Chapters 8,9, Part 6,14,3,8]. From the point of view of a "purely economic theory" (e.g. an economic theory excluding institutional and political considerations as well as the dimension of a historic evolution of a society) one could hardly be able to assess the total impact of any one of these items upon a society. Purely market economic considerations and the respective theory of value and price fall short in accounting for those public goods which have no market precedent nor very likely cannot be assessed either in part or whole in a market place. This is particularly true in most modern societies subjected to dynamic population, technological, and institutional changes. As one would suspect that Say's Law is not a very good assumption, the meaning of "economic market equilibrium" remains clouded in an empirical setting of such a dynamically changing society with possible social, political and economic dislocations over time and space. Many public policies, when introduced, provide impacts on a society not necessarily accountable in purely economic terms. The assessment of a public policy and respective public programs requires a profile with social, political as well as with economic measures.

An assessment profile for a public project should be operationally meaningful: in a given social, political and economic setting it should somehow reflect a preference ordering measurably reflected by the society: it should be valid and reliable enough in order to predict in the above setting the future response of the society to the results of the program; it should be effectively simple to be in itself cost-effective enough for practical purposes of the program selection and management. Yet it should be adaptive and empirically oriented, and be able to use a multi-dimensional system of measures predominantly characterizing social, political and economic values of a society. If an assessment profile be also reflective over time, it would span a history, present, and a future. The empirical orientation is suggested in order to recognize enough how society prefers something to be done, while apart from the empirical considerations the profile could be also constrained by normative considerations. It should be noted, however, that what someone thinks a society ought to prefer is a matter quite apart from what society actually indicates by its behavior as to what it likes.

In the framework of a mixed economy with a private sector and a public sector, the basic functions of production, consumption and saving product from consumption (investment) is taking place in both of these sectors. If one starts with the tradition of economic liberalism, then any activity in the public sector requiring overall resources for the whole economy would be considered as a sacrifice in that these resources are then no more available for the use in the private sector. For

example, taxation of income reduces the disposable income of a consumer or enterprise for the uses within the market system of the private sector, but provides, instead, financing of public investment and consumption. In the traditional Anglosaxon economic liberalism (Adam Smith) taxation is treated as a sacrifice basically because the benefits from public consumption and investment are not emphasized. Taxation here is considered sacrifice from the point of view of an individual who does not or who does not want to perceive the potential or actual benefits from the public sector activities. More precisely, in the Anglosaxon view the ability to pay taxes for public sector activities was the central theme. This view was specially emphasized by John Stuart Mill [42, Introduction]. While Adam Smith himself recognized the benefit aspect of public sector activities, the full development of the benefit-sacrifice principle evolved among the continental scholars such as Emil Sax, Knut Wicksell, Erik Lindahl and Maffeo Pantaleoni [42]. In United States the pioneers in considering "Optimal" benefit-sacrifice aspects of public expenditures are Musgrave, Bowen and Samuelson [43].

The basic concept of a mixed economy is the beneficial complementation of a private sector, typically assumed to be of the normative Walras-Pareto type, and a public sector which provides beneficial externalities for the support of the private sector and the society as a whole. Musgrave [4] assumes the following basic branches of the public sector:

1. Income (re)distribution branch: the purpose of this branch is to eliminate distortion in income distribution which, in turn causes distortions in one's ability to determine optimality of the allocation of public resources toward maximal benefit of the whole society.
2. Allocation branch: the purpose of this branch is to generate public goods necessary for the overall welfare of the society; and, which goods cannot be produced or are not wanted to be produced or which are too monopolistic to be produced by the private sector.
3. Stabilization branch: the purpose of this branch is to stabilize the overall economy due to distortions and dislocations generated by various "imperfections" of the private sector.

Without going into details, the public financing of income distribution is done by taxation, e.g. progressive income tax and by transfer payments such as social security, welfare payments, etc. The general idea is to correct the income distribution so that individuals will be in the position to reveal their preferences. It is typically assumed the public budget for doing this income (re)distribution is balanced. The same is assumed for the allocation branch generating public goods necessary for the overall welfare of the society. In the case of stabilization branch public debt may be generated in place of private debt in order to maintain the survival and appropriate growth of the

economy. For example, the tools of fiscal and monetary policies are used for these three branches in conjunction with appropriate political processes through which the society is assumed somehow to reveal its preferences.

There are some basic differences between public goods and private goods within a system of a mixed economy [4,42,43]. First, one must consider the distinction between final consumption goods and intermediate goods saved from final consumption for the expansion of the productive capacity of the society. Therefore, we must deal on one hand with the public goods for final consumption versus private goods for final consumption. Then we must deal with intermediate public goods versus intermediate private goods.

Following Samuelson [44], the ordinary private consumption goods $(X_1, X_2, \dots, X_j, \dots, X_n)$ are parcelled out among different individuals $(1, 2, \dots, i, \dots, s)$ according to the relations

$$X_j = \sum_{i=1}^s X_j^i ; \quad j = 1, 2, 3, \dots, n.$$

The public goods or collective goods $(X_{n+1}, \dots, X_{n+m})$ are enjoyed in common in the sense that each individual's consumption of any one of these goods subtracts nothing away from the consumption of each and any other individual of this same good. Therefore, for each and every i^{th} person and each and every $n+j^{\text{th}}$ public good the following relations hold simultaneously:

$$X_{n+j} = X_{n+j}^i$$

In the context of "classical utility theory" [1, Chapter 2], each individual possesses an ordinal preference schedule which is regularly smooth and convex along any and all indifference curves:

$$u^i = u^i(X_1^i, \dots, X_{n+m}^i)$$

Each individual would maximize his utility over all private and public goods under the constraints of society's limited resources to be allocated between private and public sectors. Traditionally there thought to be a maximal Pareto-optimal utility frontier, i.e. a frontier where no one can be better off without causing someone else to be worse off [44, p. 387].

If it is desired to deviate from the criterion of Pareto-optimality, then it is necessary to make some normative judgments concerning the relative ethical desirability of such deviations. In particular, this would require a set of ordinal interpersonal norms or a social welfare function representing a consistent set of ethical preferences among all the possible states of the system. Traditionally, it is not a

'scientific' task of the economist to construct the form of this function as it can have as many forms as there are possible different ethical views. Samuelson places the only restriction on the social welfare function such "that it shall always increase or decrease when any one person's ordinal preference increases or decreases, all others staying on their same indifference levels..." [44, p. 387]. In the context of the Walras-Pareto model, individuals act atomistically without externalities or inter-individual interactions. From the point of view of social psychology and sociology as well as our experience of group behavior, such an assumption from the point of view of empirical knowledge and testability and ability to predict human behavior seems, indeed, heroic. Even Pareto-optimality is a normative rather than experimentally verifiable statement in that it defines consumer rationality to be that what is Pareto-optimal and visa versa. It prescribes how I ought to behave in order to be a "rational consumer" in a Walrasian economic system.

The characteristics of the demand for public goods is that individual by individual it is aggregated vertically along the price axis in contrast to the horizontal addition of private goods for the construction of the total demand schedule. Quoting Samuelson, "...an 'analogue calculating machine' can be provided by competitive market pricing, (a) so long as the production functions satisfy the neoclassical assumptions of constant returns to scale and generalized diminishing returns to scale and (b) so long as the individuals' indifference contours have regular convexity, and, we may add, (c) so long as all goods are private." But simultaneously, the institutional framework of competition has to be maintained. A public servant needs only decide about generalized consumer income, knowing that each person can be counted on to allocate it optimally. Each consumer is motivated to do the signalling of his tastes needed to define and reach his attainable maximum satisfaction. Samuelson points out that no decentralized pricing system can serve to determine optimally levels of collective consumption. For selfish purposes of game playing, do individuals really want to reveal their true preferences? Due to selfish motives, there is a problem of detecting in a setting of a game the actual preferences of the participant players. There is a fundamental problem of social economy: by departing from "standard norms" any one person hopes to gain some selfish benefit in a way not possible under the assumption of the guidance of the "Invisible Hand". The 'external economies' or 'jointness of demand' intrinsic to the very concept of collective goods and governmental activities makes it impossible to treat the optimization problem assumed for the Walras-Pareto model.

The problem raised by public expenditure takes economics into the domain of 'sociology' or 'welfare politics'. Political economy is a special sector of this expanded perspective. The simple properties of Walras-Pareto economics would not fit such a generalized view.

In economic theory it would be possible to go beyond the extreme cases of pure private goods and pure public goods to some kind of a mixed model which takes account of all external, indirect, joint-consumption

effects. But in such a case the social optimum could not be achieved without taking into account all direct and indirect utilities and costs in all social decisions. Economic theory should add to a better understanding of governmental activity. But this would require other economic approaches, other contributions from neighboring social and political science disciplines, and concrete empirical investigations [44,45].

Traditionally, the atomistic "ideal gas theory" of the Walras-Pareto type denies the admission of externalities such as the multitude of social and political interactions. Yet it is the normative standard of the traditional welfare economics.

The impacts of public intermediate and final goods on a society are usually considered from a narrow direct cost - direct benefit point of view, whereas the important aspects of such goods could be predominantly in terms of externalities and induced or diffused effects. The atomistic Walras-Pareto system assumes away externalities; yet in macroeconomic theory one has multiplier and accelerator effects, and diffusion of economic activity over time and space. Multiplier, acceleration, diffusion and growth phenomena require assumptions on externalities being present.

Figure 2. Society's production possibilities versus social preferences for private and public goods.

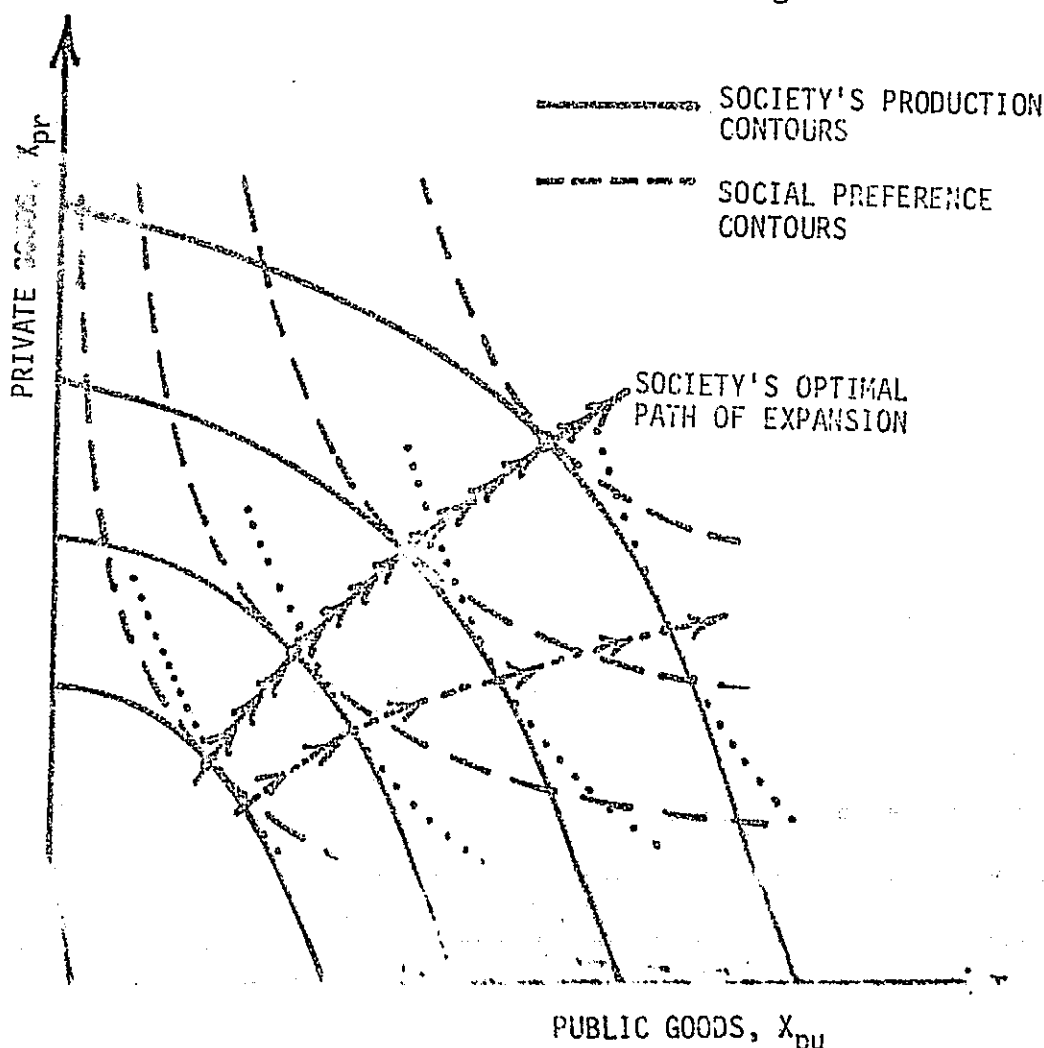


Figure 2 illustrates the production possibilities for private and public goods in various combinations for a given technology and productive capacity in increasing levels by solid contours. Since for each contour the total resources are limited this contour illustrates for its respective level of available resources all the possible combinations of public and private goods. The dashed contours illustrate the total social preference isoclines or indifference curves. The maximum social satisfaction is obtained with minimum social resources at the points where the production possibility contours are tangent to the social preference contours, sketching thereby the optimal path for the expansion of this "dual economy". This is a simple model of an optimal dual economy if we could, indeed, identify and measure the social preferences required to construct the overall social welfare preference function, and if we could determine with all externalities, the overall social production possibilities. In the highly special case where the preference contours of each and all individuals would have the same convexity as the overall social preference contour and where all the individual preference contours would have the same points of tangency as the overall social preference contours, we would have no "social" conflict.

Consider now a sub-group of the society having the preference contours illustrated by the dotted curves. This group would not agree with the overall society, but would like to expand sub-optimally toward more "left", i.e. toward a society with an increased public sector. There would be an increasing conflict with this sub-group and the rest of the society resulting, for example, in a process of political confrontation. While the conventional Walras-Pareto model treats individual preferences atomistically in a setting of perfect competition, the above model illustrates the possibility of treating a set of differing social groups in a game in which each group tries to maximize its own welfare in a setting of conflicting interests. The setting of these conflicting interests could have, for example, a game theoretical solution or compromise. There can be "rich" groups to right (i.e. toward more private and less public goods) and "poor" groups toward left (i.e. toward more public and less private goods). If the society is to remain stable, there should be a game or a political process providing a stable solution, not necessarily optimal to the groups in their original conflicting setting. One can easily imagine that the benefit-cost criteria in such a conflicting setting could be quite different from those based on the traditional but unrealistic "perfect competitive model". One possible method to achieve a stable solution would be by redistribution of income, e.g. by progressive taxation and transfer payments to low income groups, whereby the differing preference functions hopefully would be shifted toward each other. Another way of treating the problem would be the provision of differing "optimal mixes" of private and public goods to the respective groups by a kind of proportional partitioning of the private and public production efforts. Examples would be low income housing, public health care for poor, etc. There would be a preferential treatment of social groups accessing social goods, which goods now would not be equally consumed by all. In reality, this would amount to an effective income redistribution and equalization.

In reference to the static Walras-Pareto model with its atomistic individualism, economic, social, and political interest groups represent "externalities"; and the interactions between these groups represent "externalities" between "externalities". Interest groups seek goals by trying to affect the minds and actions of an identical set of people, by competing for same and limited private or public resources, by seeking limited positions in a hierarchy of a political power structure, and so on. The preferences of individuals and their behaviors are affected and modified by their roles in organizations. In a Five-Hundred Fortune economy there are powerful social, political and economic units influencing significantly both demand and supply structures and "market mechanisms" in factors and commodity markets. In public sector, local, state and federal agencies compete for same roles and resources often in a setting of gaming involving also numerous private interest groups. The scenarios of "adversary advocates" belong to the political history of mankind from the times immemorial.

With all the externalities being a rule rather than an exception, it might be more meaningful to try to identify various group and social welfare functions with some empirical measurability and operational meaning rather than trying to assume numerous individual preference functions whose effects are aggregated on an additive basis. This additivity assumption is one of the most questionable assumptions of traditional economics. With such externalities as "group hysterias" of buying, impacts of mass suggestions, diffusion and multiplication effects and avalanche effects of public opinion, etc. one must expect that collective results of individual behavior affected and modified by group interactions can be very non-linear destroying the additivity property perhaps in a highly significant way. Among other things, this has some immediate obvious implications on the traditional welfare economics and benefit-cost analysis. If additivity fails, the aggregation of such price (value) - quantity relationships as demand and supply have to be critically reexamined.

An additional complication arises when one suspects that neither social nor private preference structures can be expected to be stable over time and space; for example, they could fluctuate so much that their use for a stable base reference for economic analysis may not be very meaningful for predicting a relationship between individual and social behavior patterns. A collective society acts as a moderator and could smooth out individual fluctuations in an aggregate. Again, the use of group and social welfare structures may thus be operationally more meaningful. However, such aggregation may hide away the element of conflict between groups or individuals, and between them and the society.

Economics is a branch of social science. Typically scientific development is based primarily on extensive specialization enabling researchers to achieve significant results. The major drawback of such a development is that scientists tend to become narrow specialists for whom the broader issues in application of this discipline become some-

what irrelevant. Economics currently suffers from this malady with an alarmingly increasing pace.

Economics can be defined as a science of administration of scarce resources in human society. The focus and criteria should be on how economic activity affects society. The function of economic theory is to identify the substantive economic problems requiring solutions, to develop the best mechanism for their solution, and to achieve the maximum benefit with the resources available, given the current state of knowledge. The performance criterion of the work of economists should include the overall effects that the results of their work has upon society [46, p. 507].

There is a problem of the relevance of economics in that mathematical modeling is often based on assumptions not clearly related to the world around us. Frank Hahn in his Presidential address to the Econometric Society notes: "...the achievements of economic theory in the last two decades are both impressive and in many ways beautiful. But it cannot be denied that there is something scandalous in the spectacle of so many people refining the analysis of economic states which they give no reason to suppose will ever, or have ever, come about.... It is an unsatisfactory and slightly dishonest state of affairs [47]."

Wassily Leontief in his Presidential Address to the American Economic Association notes [48]: "Much is being made of the widespread, nearly mandatory use by modern economic theorists of mathematics.... What is really needed, in most cases, is a very difficult and seldom very neat assessment and verification of ... assumptions in terms of observed facts. Here mathematics cannot help, and ... the interest and enthusiasm of the model builder ... begins to sag .. Continued preoccupation with imaginery, hypothetical, rather than with observable reality has gradually led to a distortion of the informal valuation scale used in our academic community Empirical analysis, according to this scale, gets a lower rating than formal mathematical reasoning."

These statements apply, among other things, to the extensive and voluminous mathematical exercises, modeling, proofs of general equilibrium and its existence, etc. on the Walras-Pareto model and its extensions, including welfare economics and benefit-cost analysis. The relevance of these exercises are highly questionable. Walras-Pareto equilibrium may be an optimum situation, but it is not necessarily the optimum optimum [47, p. 509]. Policy makers and administrators have to live in an imperfect world with imperfect markets, with unknown and unrevealed preferences, with nonlogical human behavior, with social and political conflicts, with unpredictable consumers and firms, with unemployment and inflation, sudden "energy crises", with overpopulation and famine, with wars and destruction, and so on.

The realism of the situation is portrayed by the Nobel Laurate economist Ragnar Frisch [49]: "The moment the stateman starts or is compelled to formulate preferences regarding the objectives to be

reached or the course the ship ought to follow, headaches begin. Once attention shifts to the paramount question of economic development, near full employment, anti-inflationary policies, balance-of-payments equilibrium, externalities, market flaws and failures, more equitable distribution of income, and justice and welfare, certain novel and crucial questions emerge: How can human and material resources be best (or better) utilized? How can the undesirable effects of price fluctuations be corrected? How can the distorting effects of monopoly and the harmful monopolistic practices be eliminated or restrictive trade union practices be corrected? When the general questions of simultaneous attainment of rapid economic growth, more equitable income distribution, and avoidance of some of the costs of growth are considered in all their ramifications the simplicity of the market mechanism has to be abandoned. In attempting to correct social injustice in the distribution of income through national economic planning, an attempt has to be made not to lose more than is strictly necessary of the effort-releasing effect of the market mechanism [46, p. 510; 49]."

A principle of a dual economy is to preserve the private sector with its decentralized decision making and motivational drives as much as possible while at the same time providing the necessary basic social needs expressed, for example, by the criteria of an economic policy. Welfare economics and benefit-cost criteria are related to these policies and their supposedly net beneficial externalities effects on the consumers and private sector producers.

5. ON SUPPLY AND DEMAND: CONSUMPTION AS A MEASURE OF WELFARE

Ultimately production supplies the needs for consumption. The concept of consumption and, specifically, per capita consumption has been traditionally considered as a measure of welfare, if not even the main measure of welfare. Insofar as per capita consumption relates to the necessary requirements for subsistence, life versus death being the matter of choice, its utility is measurable at the subsistence threshold in terms of biological, physiological, physical, etc. quantities; and if energy requirements for labor and population increase are added, such cardinal measures for consumption requirements can be provided for economic planning of production. When one exceeds these basic consumption requirements for social survival and growth - which, indeed, could be given to a great extent in some well defined cardinal terms - then one enters the realm of consumer surplus where subsistence is assured but desires for luxuries and quality of life become increasingly important. It is in this area where individual and social utilities, preferences, and choices seem to become less well defined in, both, ordinal and cardinal sense. This problem becomes particularly complex if all kinds of social interactions and "externalities" are considered in a dynamic setting with imperfect information and learning processes. The study of demand needs then with some added emphasis dimensions of psychology, social psychology, sociology, and political science. In

relation to traditional economic theories an added empirical emphasis on a multidisciplinary approach to human needs, including production and consumption, seems necessary if we really attempt to predict human behavior in his complex ecosystem.

It seems only sensible to assume that individual and social welfare functions should have also time and spatial variables as social and economic interactions are influenced by the spatial and geographic aspects of the society and by such related dynamic processes as learning, migration and diffusion, and growth or decay of particular human activities. The space-time implications of transportation and communication on social behavior and preferences represent rather striking impact areas of cumulative social and technological learning processes over the history of mankind. The characteristics of the world population growth indicates that man has learned to survive better through his dynamic cumulative experience, and that his greatest potential enemy is the human overpopulation with respect to some essential but finite resources such as space and arable land. Social and individual preference structures have strong collective implications in such a setting. It is specifically proposed here that the space-time considerations for individual and social preference functions need to be considered, both, theoretically as well as empirically, among other things, for welfare economics and its derivations such as benefit-cost analysis. This proposal has already been made by regional scientists and economists, sociologists and so on. It is merely reiterated here for the purposes of developing some meaningful assessment profiles for public projects.

If we make psychological studies, in addition to the more traditional economic-statistical studies, do we gain an increased understanding of economic processes, and are we then able to predict economic processes with greater accuracy? Empirical evidence supports this contention [50, p. 641]. Contributions of psychological economics toward understanding of fluctuations in the consumption function is an example. Dissatisfaction has developed with the exclusive use of macroeconomic studies. While these studies are of the greatest importance, their structural aspects need to be supplemented by microeconomic data [51, p. 643]. There is a clear need to study economic behavior with demographic, sociological and regional variables over time including such aspects as habitual behavior, expectations and their influence, instability of attitudes and social learning, group behavior, multiplicity of motives, saturation of satisfaction, and so on.

Marketing people note that a consumer's rankings of alternative 'market baskets' of goods and services have traditionally been taken to depend only on the amounts of various commodities he consumes, not on the amounts other consumers are simultaneously consuming. This disregard of social interdependence in consumption contradicts everyday observation as well as the presumptions of sociology and social psychology. The basic economic decision making units are really groups such as households, corporations, governments and trade unions. So far there is no satisfactory theory of the formation of the effective preference fields of groups. It is not possible in general to derive an

ordering of alternatives for the group from conflicting rankings by group members [51, pp. 679-680; 52]. At this time there is no clear idea of the size or characteristics of the population groups whose behavior can be represented as maximization of expected utility [51, p. 681].

Assuming the presence of a variety of social interactions, group interests, imperfect information, non-revealed preferences, learning and so on, there will be a problem to relate the overall price-quantity demand schedules at various aggregated or -better- collective levels to the individual or group preference fields. Without an adequate understanding of the "externalities" the bridging is not possible between the individual welfare and that of the society. This would suggest that the welfare problem as an aspect of consumption behavior might be done at a group level, where each group is somehow identified by some commonality and a group identification of its individual members. For example, there are socio-economic, political and cultural "interest groups" who compete for same scarce resources. Through economic, social and political processes they "game" to reach a variety of compromise solutions over time and space [52]. The problem of understanding demand with externalities present also is the problem of understanding supply with externalities present. Although we can add quantities, the question is what do we really mean by prices in relation to the welfare of more or less deaggregated interest groups. For example, on supply side, firms may simply take an administrative pricing approach to some more or less fixed level or quantity of output produced. This would be consistent with their attempts to maintain an appropriate market share with the cost advantages of their experience from the total cumulative volume of production. A firm keeps prices low enough to keep competition out in order to maintain its relative position in the market place.

The possibility of looking at preference fields at group levels (thus including a set of "externalities" and their effects) is reinforced by reframing the classical "rationality" models within cognitive theory. First, "rationality" is defined certain way in economics. This definition does not assure its empirical validity in relation to actual human behavior. For example, labor economics, economics of imperfect competition, decision making under uncertainty and theory of economic development as areas where the classical definition of "rationality" is highly questionable. The classical "rationality" is too simplistic as a motivational theory in the psychology of human behavior: The decision maker's model of his world contains only a minute fraction of all the relevant characteristics of the actual environment, and his influences extract only a small fraction of all potential information that could be present, even in his model. Under these circumstances, his choices cannot be predicted from a knowledge of the external environment without a knowledge also of the individual selective mechanisms that are part of his perceptual and problem-solving processes. Individuals acquire "frame of reference" roles. Limited data, feasibility of computation, and an ability to choose a proper approach to prediction include aspects of subjective rationality. There is a difference to consider an economic man as a satisfying man versus a maximizing man. In particular, he relates to his role in this

regard. A cognitive theory could provide a much more universal approach to "human rationality" across social sciences than the particular assumptions arising from traditional economics [50, pp. 685-723].

Consumption at the level of an economic unit or at levels of various aggregates can be measured as an experimental fact. It is possible in a market economy or a planned economy to find or prescribe a price-quantity schedule called demand curve. In a planned economy pricing is done by planners of some market mechanism. In this case, one talks of accounting (or shadow) prices and wages. Wage and price controls force out such shadow prices and wage rates. In a mixed economy, the price-quantity relationships for demand and supply are directly or indirectly generated by the joint effects of the private and public sector. For example, public sector can induce "externalities" on the private sector by taxation-transfer payment mechanisms, by public subsidy and financing of research and development and the respective transfer of technology, by development of public highways, airways, etc., as well as providing education and development of human capital. Thus, the public sector can affect income distribution, allocation of real resources in the private and public sector, and the evolution of production technology for private sector, and so on. The "social preference function" expressed in terms of a socio-political and economic policy, is supposed to guide the social activity toward some direction of welfare maximization. Public programs are "benefit-cost" oriented and "cost-effective" if they are somehow consistent with such a public policy as an expression of the revealed preferences of the society.

Above a threshold subsistence level, if consumption represents a measure of individual and/or social welfare, it is desirable to measure somehow the relationship between consumption and the various assumptions on consumption preference fields, individual or social. If consumption in conjunction with growth, survival and maintenance of relative position of power is considered as the main purpose of production, then it is only reasonable to attempt to relate actual consumption behavior to the various suggested consumer behavior models in a comparative sense. Econometric methods have been used to do this kind of a comparative study. Several economists have treated this problem [53,54,55,56], and at the present conclusions are not yet very consistent. It is worth noting that if benefit-cost analysis rests on "consumer surplus", over and above of consumer survival, then such search for relevant consumer behavior patterns is, indeed, crucial. In this regard, also, the notion of the consumer surplus is not empirically very clear, except insofar as we can define the necessary requirements for basic survival.

The Marshallian consumer surplus is defined as follows [40, p. 124]: "We have .. seen that the price which a person pays for a thing can never exceed, and seldom comes up to that which he would be willing to pay rather than go without it: so that the satisfaction which he gets from its purchase generally exceeds that which he gives up in paying away its price; and he thus derives from the purchase a surplus of satisfaction. The excess of the price which he would be willing to pay rather than go without the thing, over that he actually does pay, is the economic measure

of this surplus satisfaction. It may be called consumer's surplus. There are many comforts and luxuries of which the prices are very much below those which many people would pay rather than go entirely without them; and which therefore afford a very great consumer's surplus." It is noted, then, that the Marshallian consumer's surplus must be somehow defined with respect to the consumer's preference field, if this be identifiable and measurable in the first place. It should be also noted that if the effort expended by an individual for his mere survival is much greater than his effort in a setting of a social structure, then in this structure he obtains a "consumer's surplus" for survival, i.e. he can evaluate his "ease of survival" in a society with externalities versus his ease of survival without them. If the society helps him to survive, then there is a surplus in his favor. National defense, protection from disasters, and so on, belong to this "consumer's surplus" category. The concept of "consumer's surplus" could be carried under some assumptions on to the level of a variety of interest groups as well as the society as a whole. The notion of consumer surplus does remain ill-defined if a variety of "externalities" are introduced. A particular demand schedule for a given commodity assumes "other things being held constant", which in a world of interactions and "externalities" is an unrealistic assumption. An interesting special case is the backward sloping demand curve: a quantity demanded drops as its price drops. Many "status symbol products" are in this category. Externalities, social roles, neighborhood effects, and so on, underly this situation. A luxury car is increasingly desirable only if its price is high enough to exclude the "common man".

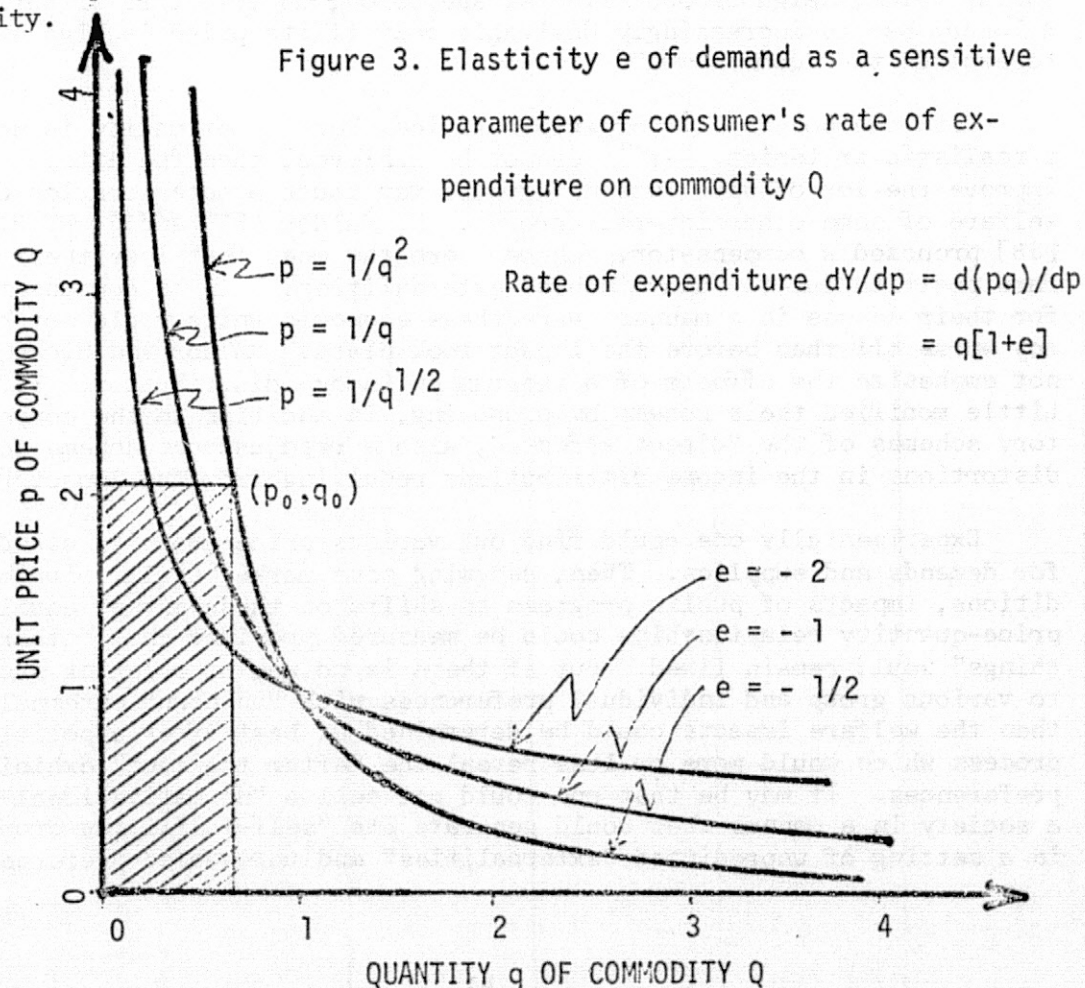
With the possibility of externalities, Pareto optimality is no more a realistic criterion. If it cannot be achieved, then the attempts to improve the lot of some interest groups may cause a deterioration of the welfare of some other interest groups. N. Kaldor [57] and J. R. Hicks [58] proposed a compensatory scheme where the ones that lose their welfare position due to "unavoidable" externalities, will be compensated for their losses in a manner where these economic units would not be any worse off than before the impact took place. Kaldor and Hicks did not emphasize the effects of a program on income distribution. I. M. D. Little modified their scheme by proposing, in addition to the compensatory schemes of the "direct effects", also a readjustment scheme for distortions in the income distributions resulting from the impact [59; 4].

Experimentally one could find out various price-quantity schedules for demands and supplies. Then, assuming some market equilibrium conditions, impacts of public programs as shifts on these market equilibrium price-quantity relationships could be measured provided that "other things" would remain fixed. But if there is no way of relating such shifts to various group and individual preferences with "unknown" externalities, then the welfare impacts could be determined at best after a political process which would more or less reveal the "after the fact" exhibit of preferences. It may be that one could not sell a "normative ideal" to a society in a manner that could generate its "self-fulfilling prophesy" in a setting of unpredicted "externalities" and unrevealed preferences

of various interest groups. Rather than attempting to take an overtly normative approach, the leadership and elite might have to consider an increased empirical effort in order to detect the nature of the society with its interactive subsystems in order to sway and control its minds and actions in a planned direction.

Ultimately, welfare as consumption is concerned with a subsistence level survival and the consumption surplus above it. Consumption is supposed to set targets for production and its capacity requirements over time. Public programs can affect, both, consumption and production directly i.e., demand and supply. There is a substitution effect between private and public consumption as well as private and public production. There also could be positive or negative synergies between the activities of these two sectors.

Traditionally, welfare measures relate to consumer incomes and surplus. Given an income, externalities may increase, leave unchanged or decrease consumer expenditure on a particular commodity. The basic knowledge of demand characteristics is typically assumed in evaluating an impact of a public project on consumer surplus. Since consumption measures welfare production exists for welfare. Production relates to supply which can be affected by externalities due to public projects. The traditional analysis follows Walras-Pareto and Marshallian lines. A partial analysis assumes "all other things kept fixed" and looks only at the interplay of the supply-demand interactions of a particular commodity.



A rather sensitive parameter related to the rate of change of consumer's expenditure on a commodity Q with respect to its price change is the elasticity e of demand, $e = (dq/q)/(dp/p)$; q is the quantity of Q demanded. Figure 3 illustrates this concept. The consumer's expenditure on Q is $Y = pq$ for each demand curve shown. The shaded area illustrates the case where $y = p_0 q_0$ for the demand curve $p = 1/q^2$ with elasticity $e = -1/2$. In this case, as price p drops, the rate of change of consumer's expenditures on Q with respect to the price p also drops. The demand curve with elasticity $e = -1$ is such that consumer's expenditure $Y = pq$ remains constant with changing price p . If $e = -2$, then dY/dp increases as p drops. In general, if $e > -1$, the consumer benefits with decreasing price p insofar as he then spends less on commodity Q . If $e = -1$, price changes have no effect on his expenditure on Q ; and if $e < -1$, his expenditures on Q will increase with decreasing price p of Q . Therefore, the elasticity e of demand is a property of the consumer's preference function, and its estimation would tell us something about an impact of a program on consumers' income allocation. Its estimation for benefit-cost purposes can be useful in that it helps us to evaluate consumer's income allocation situation and consumer's surplus as a public program affects the commodity pricing situation.

Of course, the concept of elasticity can be applied also to supply curves. If they are upward sloping then elasticities would be positive. The supply side of analysis is essential in that the externalities introduced by public sector activities can affect production cost functions and marginal cost functions (i.e. supply function). In this discussion a specific example suffices to illustrate the impact of an externality in a setting of a partial analysis. Consider a necessity with a minimum requirement q_s for the survival of a social consumption unit. Assume a demand schedule with an elasticity $e > -1$ for this necessity. It could be an agricultural product such as corn. Let $S_1(q)$ represent the supply schedule of an old agricultural technology. Then a public program is established to modernize agricultural technology resulting in a new supply schedule $S_2(q)$. When the new technology is introduced, the price drops from p_1 to p_2 and quantity demanded increases from q_1 to q_2 , respectively. The consumer's expenditure changes from $Y_1 = p_1 q_1$ to $Y_2 = p_2 q_2$. The difference $Y_2 - Y_1 = p_2 q_2 - p_1 q_1$ represents a surplus income released to the consumer in this process. So long as the area A in Figure 4 is greater than the area B, the consumer benefits from the project. Figure 4 gives an illustration of this kind of analysis.

The traditional microeconomic approach can be extended beyond the partial analysis under various simplifying assumptions. The serious problems relate to the nature of possible interactions or externalities and the lack of accounting for economic dynamics, such as technological progress or population growth. Further problems relate to the nature of consumers' preferences, behavior of firms, and the nature of market mechanisms. These are some of the problem areas that generate serious questions about the operationality of the classical welfare economics in a real world. However, the Walras-Pareto fixation is a traditional reference model for much of the current effort in welfare economics and the related economic impact analysis.

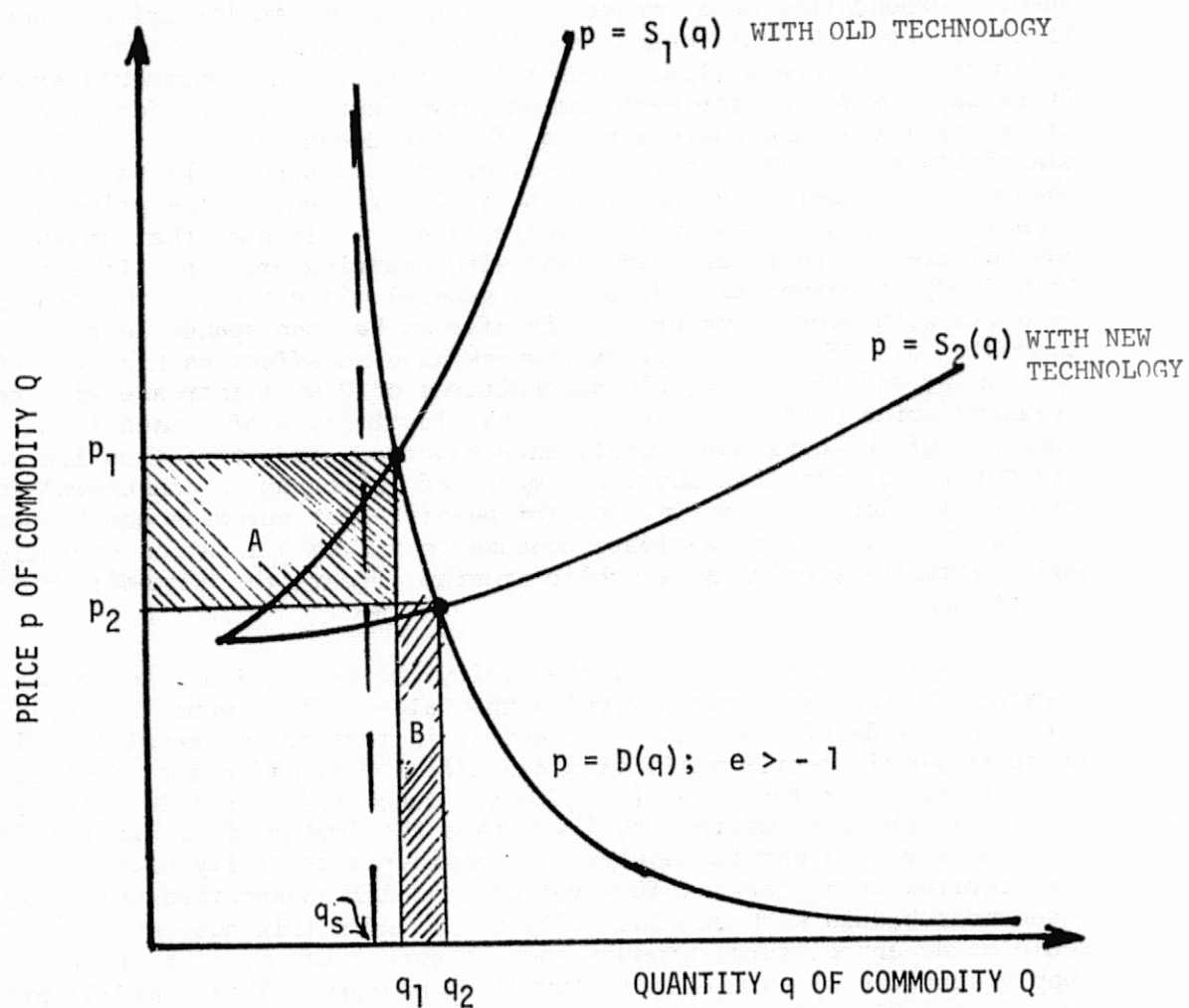


Figure 4. An illustration of an effect of technological change on consumer's expenditure on commodity Q; a setting of partial analysis.

This kind of a welfare impact analysis has been extended in several directions in the framework of the classical microeconomics [60]. The concept of consumer surplus is one of the traditional handles of accounting for benefits or penalties due to externalities of public sector and private sector against the assumed standard of the perfect competitive system of Walras-Pareto. It should be mentioned here specifically against the background of the previous criticisms of the Walras-Pareto fixation.

The traditional welfare economics can be carried into an "applied welfare economics" by postulating [61]:

1. The competitive demand price for a given unit measures the value of that unit to the demander;
2. The competitive supply price for a given unit measures the value of that unit to the supplier;
3. When evaluating the net benefits or costs of a given action (project, program, or policy), the costs and benefits accruing to each member of a relevant group should normally be added without regard to the individual(s) to whom they accrue.

Typically it is assumed that professional economists are not in a position to pass value judgments on the basis of their expertise concerning what is "good or bad" for social preferences. However, in the traditional economics the existence of a real "competitive demand" and "competitive supply" is assumed as a standard which in fact may not exist at all in a "real life" situation for a realistic benefit-cost analysis.

Further, it should be noted that:

1. Consumer-surplus analysis is valid only when the marginal utility of real income is constant.
2. Consumer-surplus analysis does not take account of changes in income distribution caused by the actions being analyzed.
3. Consumer-surplus analysis is partial-equilibrium in nature, and does not take account of general-equilibrium consequences of the actions whose effects are being studied.
4. Consumer-surplus analysis, though valid for small changes, is not so for large changes.
5. Consumer-surplus concept has been obsoleted by revealed-preference analysis [61].

The traditional Walras-Pareto fixation appears in Harberger's comments such as "externalities of all kinds represent distortions..." rather than treating "externalities" as "internalities" of a typical human society. Nor is he doing very much in trying to pull out of the very static framework of the traditional "equilibrium" economics.

6. BENEFITS, COSTS, AND ALL THAT

The question of efficiency of an economy must be related to some criteria of objectives and goals or an "objective function" as well as to a set of identifiable constraints under which the social welfare expressed by the "objective function" is to be maximized. This whole problem can be either normative or positive, or a mixture in the sense that the actual economic behavior is directed toward a normative setting, for example, by some appropriately designed economic policy. While the perfect competitive Walras-Pareto system assured, a priori, the maximum welfare and optimal behavior as defined for and by the model, the world around us just did not behave according to this normative framework. The "private sector" was not so perfect, not so efficient, not so welfare maximizing as assumed by the model. The distortions from the norm had to be treated and re-aligned by an intervention of a "public sector". But such an intervention and "tampering of a natural law" by a government generated additional questions about the efficiency of a public policy and control. The efficiency of government became a prime issue of public in United States through the depression years. While a variety of inefficiencies of private enterprises could be hidden from the eyes of public, the efficiency of a government was exposed to the continuous scrutiny of the public eye.

In 1937 Thurman Arnold wrote: "The conception of social institutions as having free will, and winning their salvation by a free-will selection of the right principles; the idea that politics, pressure groups, lobbying, powerful political machines existed because people had sinful yearnings in that direction; the economic idea that depressions were the result of tinkering with economic laws and preventing the automatic working of an abstract law which would have functioned properly had it not been for bad men who threw this law out of gear - these were held as articles of faith by conservatives and radicals alike. They all showed distrust of any form of organized control. No one would admit that man should govern man. No one would observe the obvious fact that lay everywhere under their noses, that human organizations rise to power, not by following announced creeds, but by the development of loyalties and institutional habits [62, pp. 70-71]."

The efforts of Veblen and Arnold, among others, were in the direction of understanding the social psychology of human institutions, an attempt already paved, for example, by Pareto in his Sociological Writings. As economics was taken only as an aspect of a society and interrelated to its psychological, social and political dynamics, its

trend of evolution should not have been in the direction of an isolated science. Alfred Marshall, himself, continuously warns us about this grave danger. Yet, today, an amazing volume of benefit-cost literature is based upon the rather restricted and unrealistic Walras-Pareto model. Much of this may turn out to be nothing but sterile exercises not amenable even to some meaningful empirical verification. In particular, the assumptions about consumer behavior, behavior of firms, the existence of economic, social and political groups with numerous interactions, and processes of human activity over time and space are either unrealistic or non-existent.

One of the great American welfare economists, Richard A. Musgrave [63], reviews the relationship between benefit-cost analysis, first noting that it is necessary to consider jointly the revenue and expenditure sides of a public budget. Then he notes some of the classical criteria of efficiency (A. C. Pigou): "The composition of public expenditures should be selected so as to equate their marginal social benefits; the composition of taxes should be chosen so as to minimize total social cost; and the size of the budget should be carried to the point where marginal benefits and costs are equal. but (this) says little beyond demanding in general terms that the public sector should be efficient. The real question is how costs and benefits are to be determined, and how they are related to each other. Tax-costs in terms of taxpayer sacrifice cannot be determined unless cardinal utility schedules are comparable and known apart from this, the Pigovian model remains inadequate because it offers no mechanism by which benefits are to be measured ... Generally speaking, cost-benefit analysis provides no substitute for the basic problem of evaluation in the case of final social goods. All it can do is to expedite efficient decision making after the basic problem of evaluation is solved." ... Since the intermediate social good through products is converted "into final private good, the benefit of such a social good can be measured in terms of the market price of this (now private) good. ... It is thus in this case of the intermediate social good that cost-benefit analysis can perform most effectively. ... by taking policy constraints for granted, and thus saddling the single instrument of public investment with multiple objectives (mix of public and private investment, correcting the level of total investment, correcting income distribution), the second best nature of the (benefit-cost) approach is accepted perhaps too readily, thereby reducing its normative value where the use of multiple instruments ... could give better results." - (Perhaps, some kind of a "total assessment profile").

The nagging problem, both theoretically and experimentally, is to identify a social preference field that could be used as a base for the construction of an appropriate social objective function. In this regard, Musgrave, Arrow and others point out to the political process and in particular to the history of Congressional actions as a source of information for a synthesis of a cardinal social preference function. Such a preference function would potentially reflect a variety of economic, social and political interactions or "externalities".

From the side of economic there is a considerable effort to treat the questions of externalities [64]. From the point of view of an operationally relevant economic theory it seems that much experimentation is needed, and that one may have to stick to rather aggregated levels of economic behavior for practical policy considerations except in those rather obvious cases of powerful institutions and interest groups which are capable of distorting economy in some undesirable direction. As a matter of positive economics, it is typically more meaningful to structure out into various directions from an aggregated level rather than somehow trying to compile "aggregates" from the level of microeconomic units. The structuring or decomposition of a macroeconomic model can be done in terms of identifying meaningful social groups and institutions as sub-systems, and then treating these subsystems in an interacting structure. Leontief's input-output model for American economy is an example. The real problem comes in when it is recognized that social, economic and political interest groups can be viewed only from a particular perspective in terms of traditional economics, and that economic behavior, preferences, etc., are motivated by non-economic factors, such as roles, group identification, cultural influences, emotions, social conflict, love, hate, hunger, crime, and so on.

In recent years there is an increasing interest to generalize benefit-cost analysis into non-economic dimensions in the sense of the traditional neo-classical economics, such as attempts to consider such overlapping criteria as environmental, economical, political, social, technical or technological, resources and needs for the purposes of water resources planning [65]. It has been pointed out that it is impossible to measure social conditions in terms of one overall aggregate. There seems to be at least three distinct aspects of social conditions: 1. Demography. 2. Social relations. 3. Welfare [66]. Also, economic, social and political impact studies can be expanded into temporal and spatial dimensions, or in the direction of space-time dynamics.

A. R. Prest and R. Turvey provide a survey of benefit-cost analysis to about 1964 [67]. The survey discusses applications, powers and limitations of the method. For the purposes of this discussion their conclusions are appropriate. First, they point out that there is a wide divergence of the views about the role and usefulness of benefit-cost analysis. Some people see it as a revolutionary in its practical policy implications. Against this perhaps exaggerated view, others note the dependence of the costs and benefits on judgment, guestimation, reliability and relevance of information; and that a mere ritual to compute benefits and costs in terms of some specific numbers does not thus assure the usefulness of these figures in planning and decision making processes. Prest and Turvey point specifically out the difficulties on the side of enumerating and evaluating benefits. One of these difficulties with enumeration of benefits is possible overlapping of categories. On the evaluation side the real problems relate to one's ignorance about utility or preference functions and how to measure them, the fact that the traditional economic theory is inadequate in accounting for effects of

"externalities", the ambiguity in choosing an appropriate social discount rate, and the difficulty of including uncertainty into benefit evaluation. This last point is especially important in relation to public projects relating to natural and man-made disasters. An advantage of benefit-cost analysis is that it forces possibly a better problem definition, and can provide a potentially meaningful partial analysis in ranking alternatives.

7. CONCLUSIONS: ON THE POSSIBILITY OF A TOTAL ASSESSMENT PROFILE FOR THE SELECTION OF PUBLIC PROJECTS

A society grows among other things on the basis of a dynamic learning process. This includes also a judgment between the emphasis on a normative versus positive approach to a "benefit-cost" evaluation in selecting goals and objectives for a given set of available resources. Model building is an art of map building. There is a need to mix normative and positive considerations of social knowledge in order to give us some kind of accountability of the direction of motion. If one fixes arbitrarily the perspective and dimensionality to look at a social process, then there is the danger to be prisoned in a barrel excluding, a priori, the way to look at the world from some other perspectives. The Walras-Pareto fixation is an example. Experimentation and learning with a guidance of a tentative reference map does not exclude the possibility of revising this map in some new relevant direction as an "adaptive system". The social stresses generated by the excessive adherence of an "elite" to idol fixations can generate revolutions in order to achieve an anticipated higher level of "benefit-cost" state for the general public. If the benefit-cost practice is to be elevated from a local ritual to a globally meaningful level it must be somehow referenced to a perception of an "overall socio-economic and political" system. It may be in this area where the "long-run planners" can conflict with "incremental decision makers". Incremental decision making has two aspects: First, it could be considered as an adaptive process anticipatory with respect to a long-run plan. In this sense it has the characteristics of a preventive process. Second, it could be considered as a remedial process after the fact. In this latter case, "we just did not know enough"; that is, ignorance and uncertainty prevented us from correctly anticipating the future.

The preventive process is anticipatory, preparation ahead of the occurrence of an anticipatory event, feeding forward in time by generating a state of readiness. The remedial process is a medication after a wound has been inflicted. It is an attempt for a corrective feedback. A long-run plan sets a contemporarily perceived tentative reference against which performance is measured in an adaptive sense including the long-run plan itself. This whole process relates to our ability to perceive future within some meaningful time-horizon and then be willing to adapt to changes as we learn more about the situation. The interesting question is how to penetrate through a more or

less unknown dynamic situation toward a target with "least effort" or expenditure of resources while the position of the target and the state of the seeker are changing over time.

The danger of the "traditional approach" to benefit-cost evaluation is its adherence to a static and irrelevant reference criterion, the Walras-Pareto model and its relatively minor modifications. This reference criterion lacks many of the observed characteristics of the so-called "real world". It does not seem realistic to assume that the contemporary economics can come even near to absorb all the relevant dimensions of those social processes perceived by us today. If our present economic models could, indeed, claim such a great power, they must be presented in the framework of an all-encompassing closed system. There is no faintest reason to believe that this is the case. Certainly, the Walras-Pareto model is not such a model. This leaves us a little bit on limbo on what to do to include those seemingly important psychological, social and political processes into our conceptual construct or "model" of the society that ought to behave in some specified manner of effectiveness. In some ways biologists are better off: they do not need prices and "value" of money to measure the survival effectiveness of a species. An ecologist must view several factors affecting the life-cycle of a living organism in a conjoined interaction with its environment. The "cost-effectiveness" of an organism is characterized by its dynamic life-cycle of survival, growth and death.

Perhaps, the next meaningful attempt in the understanding of social effectiveness and survival is a more general systems view than that afforded by the conventional economic theory. Such a view should be accountable by the choice for its logic and by its empirical relevance that provide a meaningful framework for experimental verification. One of its measures of success is its ability to set and identify a scene in which it can predict human and social behavior, and that at the same time it is operationally feasible or has the characteristics of "effective simplicity". In particular, it need not be assumed that benefits and costs can be measured in a one-dimensional space: a multi-dimensional benefit-cost approach might very well be far more "practical" approach than the traditional approach which is forced into the one-dimensional financial picture as though the human and social values were simply reducible to a simple scalar dimension no matter what the multi-dimensionality (vector, tensor) its nature could be.

There are and have been several suggestions how to improve or extend the scopes of economic theory, welfare economics, and, in particular, benefit-cost concepts. This treatment does not attempt to cover except a small portion of them. Insofar as economic theory is concerned with, some of the suggestions are listed below:

1. The possible complexity of microeconomics may grow beyond any practical consideration if one introduces a great number of all kinds of potential interactions between consuming units, between producing units, and between

consuming and producing units of an economic system. Therefore, the attempt to aggregate upwards from an atomistic level with added complexities of all kinds of interactions and inter-individual differences is possible only, perhaps, in some kind of a statistical framework.

2. The other possibility is to consider some relevant collective economic, social and political institutional units or groups within which a number of "externalities" are absorbed into a collective resultant as an intra-groups behavioral characteristic. The problem of "externalities" is then pooled into a set of collective social groups or entities with some major inter-group interaction characteristics between them. The pooling need not be a simple additive process but rather a process of perhaps a nonlinear or identification of a relevant social, economic and/or political "subsystems".
3. The portrayal of the behavior of the relevant collective social, economic, and/or political units should not be restricted within a static framework, but should be extended into a dynamic space-time domain.
4. The socio-economic-political preference fields of the collective social units need not be expressible in terms of a scalar function, especially if price formation and values cannot be completely related to the cognitive preference fields of these units.
5. If economic considerations alone are not sufficient to predict socio-political behavior then other considerations must be introduced in order to fully justify any benefit-cost consequences. In particular, it might be necessary to consider several possible dimensions for the background "all other things being given" before it would be meaningful to consider an economic model as a setting of a partial social analysis.
6. Admitting the possibility of a multi-factor approach to socio-political space-time dynamics, it seems only reasonable to assume a considerable amount of empirical investigation guided by theoretical considerations before some operational vehicle can be innovated for planning and decision making purposes. Most successful practical decision makers recognize those few and selective essential patterns of relationships that allow them to realize and control a direction of activities toward a goal.
7. If one wants to consider a total assessment approach to the process of program selection, then he must assume as closed as possible of an environment for this decision process, over its specified time and space horizons.

8. The process of developing an operational vehicle of benefit-cost evaluation requires a combination of experimental investigation and theoretical innovation. In particular, a normative reference model, formerly successful, may lose its motivational power and realism in processes of social change. Therefore, experimental verification of theoretical innovations suggest a way of redirecting norms toward reasonably realizable directions.
9. A policy extracted through a political process may be consistent with the cognitive preference field of a society; but it in turn will very likely affect this preference field. The interaction between a public policy and the preference field of the respective society needs to be considered as a modifier of the social preferences and, therefore, a modifier of the public policy.
10. If a society is viewed from an overtly collective perspective many potentially important interrelationships for social survival and stability may be swamped out. A structuring and decomposition of such a view to a set of effective social power units is then desirable. While this has been done by industries (e.g. inter-industry models), regions, (inter-regional models) etc., it must be also done in terms of socio-political power structures not directly correlating with their pure economic power. While the dimensions of power are economic, militaristic and cultural it is very questionable that these dimensions can be reduced to a common value dimension such as dollars.
11. The dimensions for assessing a public project or a program should consider all aspects and items of a recognized existing public policy plus all those that seem for the time being relevant. Typically, this would take us readily outside of the simple market considerations.
12. A partial analysis is relative in the sense that it assumes "an almost fixed background" in the sense of time (short versus long run), in the sense of space (local versus global), and in the sense of complexity of interactions (simple versus complex), as well as in the sense of number of hierarchies to be considered. In all these dimensions one can have a choice from "micro" toward "macro". An entity is given against its background. As we increase its perspective, the entity absorbs more and more background into it as its own foreground. If the background is considered "given and fixed", then the foreground can be treated as a matter of "partial analysis".
13. A test of the effectiveness of the foreground model is its ability to predict social behavior against a fixed background. Whether one can test experimentally the foreground

model against its assumed fixed background depends on the ability of the model builder to choose his portrayal of the foreground as isolated enough in its "localized" behavior from the effects induced by this behavior through its background back to the foreground. A total systems approach would call for an appropriate degree of inclusion into the foreground until a sufficient level of isolation might be reached for empirical verification for the behavior of the foreground. Where interactions are strong and nonlinear, such an isolation may not be possible.

14. In general, it may not be possible to assume that an observer, and entity observed and the background setting of this whole process are separable.

The purpose of this discussion has not been to completely reject benefit-cost analysis as it is defined traditionally. Rather, the purpose is to emphasize the need to develop a set of relevant measures to be added to just one "economic" measure. This set of measures need not represent an "orthogonal set" of measures, but measures that could have a degree of commonality. But they would relate to the processes of social action in such a manner that we could have a more complete characterization of social preferences than that given by the value measure of the traditional economics. For example, there are processes in a society that could be almost totally excluded from what we call economic activity. Yet, these elements can be crucial to the stability and survival of the society either in short or long run. Market oriented economics may not be able to account for a variety of imaginable social costs; nor are these costs necessarily in terms of market values. In a modern society the role of public policy spans beyond mere commercial purposes and purely economic ends. The assessment of public policy and public projects goes well beyond dollars and cents. The attempt to justify these policies and projects purely in pecuniary sense may be hazardous to the social health. While this discussion has centered on the economic foundations of benefit-cost analysis, the resulting suggestions point in the direction of an assessment profile including a relevant set of possibly non-economic factors and considerations, such as those relating to psychological, social, political and cultural factors over time and space not normally explicitly included in our current economic theories.

III. AN OVERVIEW OF PLANNING-DECISION PROCESSES: A PERSPECTIVE FOR BENEFIT-COST ANALYSIS

1. INTRODUCTION

Especially since World War II there has been an increasing emphasis on formalized long-run planning and decision processes, and respective

supportive policy, strategy and administrative sciences in the United States. In many ways the history of benefit-cost analysis fits this trend. On one hand, benefit-cost analysis could be viewed as an attempt to provide a "maximum" economic justification of a public program by itself. On the other hand it also can be viewed as a method of choosing a "best possible" alternative in a strategic and operational setting, where a program is an aspect of a complex total planning-decision environment including a multitude of interactive considerations, alternatives, and programs guided by some policy.

The purpose of this section is to give an overview of planning-decision processes hopefully providing thereby a respective perspective for benefit-cost analysis and its possible extensions toward an economic-social-political impact analysis for public projects.

2. PLANNING AND DECISION PROCESSES: A BACKGROUND FOR BENEFIT-COST ANALYSIS

Long-run planning is an increasingly important aspect of modern private and public institutions and operations. A review of planning and decision processes is an essential background for benefit-cost analysis. The purpose of this review is to provide a basic overview, not a comprehensive treatment, of such processes. A basic notion of planning is that in a dynamic complex and possibly conflicting environment events can be created, directed and controlled to generate some desirable end results over time and space. The dimension of time is essential. Figure 5 illustrates the temporal setting of a planning process.

Figure 5. A simple illustration for a temporal setting of a planning process.

Once upon a time
we were here.

Now we are
here.

We want to
be here.

WHOSE ASSESSMENT OF THE PRESENT?

Where were
we in past?

Where are we
now?

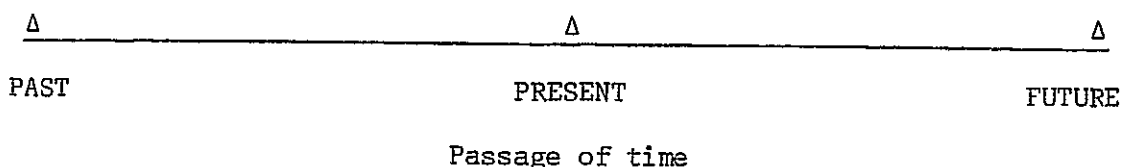
Where do we
want to be
in future?

How did we get from where
we were in past to where
we are now?

How do we get from where
we are now to where we
want to be in future?

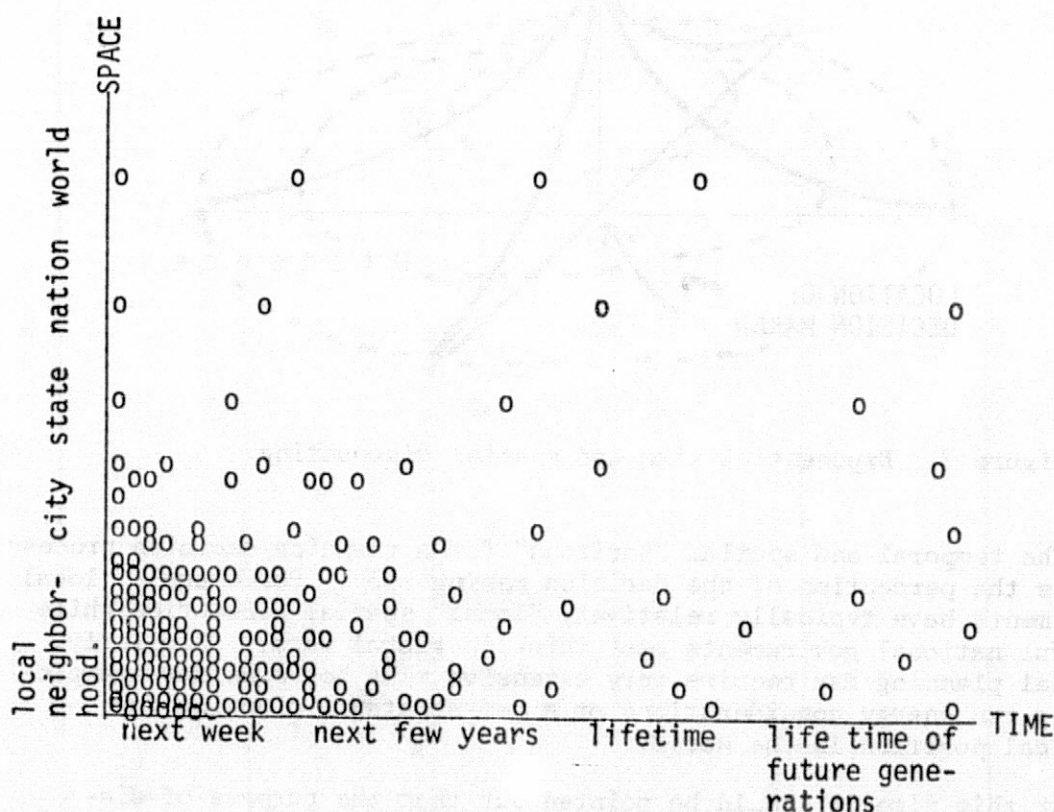
WHOSE HISTORY? WHOSE INTER-
PRETATION OF THAT HISTORY?

WHOSE PREDICTION, FORECAST?
WHOSE PLAN FOR THE FUTURE?



A planning-decision process assumes a time horizon from a past to the present and then to a future. The respective planning-decision agency or institution perceives a span of time more or less discounting over the very remote past and a very remote future. An example of such time discounting is the simple exponential discounting used in capital and financial decision making. The discount rate for the past history may be different from that for the future. The higher the discount rates are the more temporally "local" is the respective planning-decision process: the smaller are these discount rates, the more "global" is its respective planning-decision process. Analogous treatment applied to spatial discounting. Figure 6 illustrates the relative number of "local" versus "global" planning-decision processes [24, p. 19]. The important visions and planning-decision processes in the world concomitant with the respective magnitude of either military, economic or cultural political power tend to belong to the global spatio-temporal dimensions. Figure 7 illustrates the temporal and spatial discounting processes.

Figure 6. "Local" versus "Global" space-time perspectives (perceptions): A relative frequency (illustration).



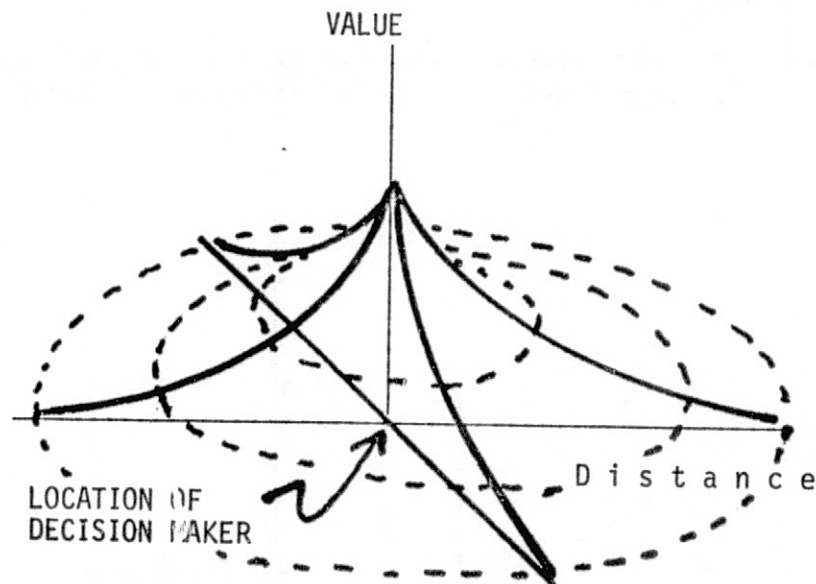
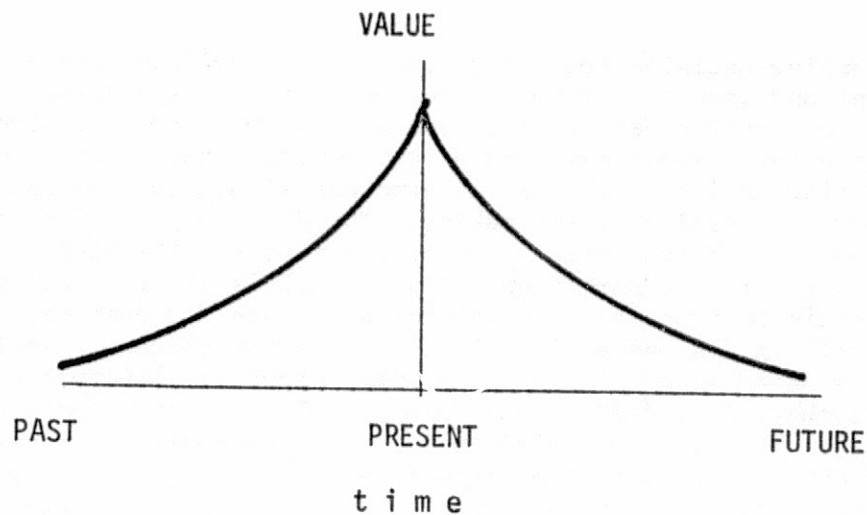


Figure 7. Exponential time and spatial discounting.

The temporal and spatial "horizons" for a planning-decision process express the perception of the decision making body. For example, local governments have typically relatively "local" spatial perception while powerful national governments must think in global terms. Similarly, national planning may require very extensive time horizons for example in long run energy considerations or a geo-strategic planning for political position in the world.

At this time it should be pointed out that the purpose of discounting over time and space is to localize the time and spatial horizons for a specified planning-decision process. The higher the temporal and

spatial discount rates are the more localized and immediate the results of a planning-decision process are perceived to be by the planning-decision agency or institute. High discount rates favor "local" decisions against "global" decisions.

Erich Jantach [68,69] considers the following levels of planning:

A. POLICY PLANNING. The purpose of policy planning is to identify or synthesize possible alternative future goal patterns, "possible futures", or functional objectives for the future. These are usually generated on the basis of conceived alternative future scenarios or possible future environments. Another aspect of the policy planning is to select those possible future goal patterns that are in some desirable harmony or relationship to a broad societal value system (in particular, including its economic, social and political dimensions). In this manner a normative aspect is introduced to the planning process at its policy planning level.

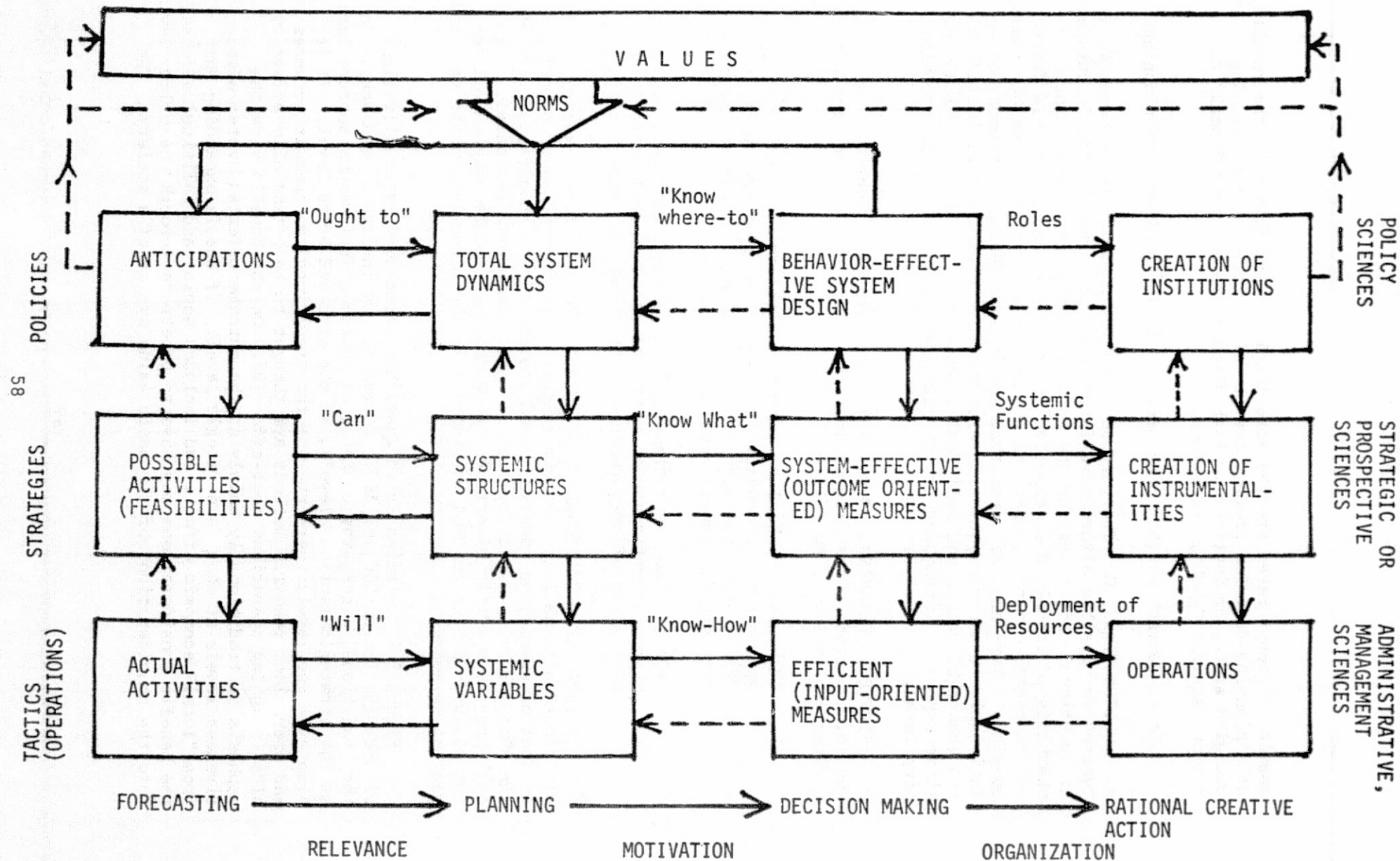
B. STRATEGIC PLANNING. Given a goal pattern consistent with a value system, selected in the process of policy planning, the function of the strategic planning is twofold:

1. Identify, synthesize, construct a relevant set of routes, approaches, alternatives to reach the given goal pattern. The alternatives should be realizable, feasible enough for a meaningful consideration.
2. Select a "most efficient" subset of these alternatives which is sufficient to reach the selected goal pattern with least effort, resource commitments and uncertainty.

C. TACTICAL OR OPERATIONAL PLANNING AND CONTROL. Once a set of "most efficient" alternatives has been selected, the next phase of planning is that of specifying, designing and implementing a specific program at the nuts and bolts level for each selected route or alternative. For each program specific milestones or objectives must be singled out for the measurement and control of progress in the direction of the selected goal pattern.

Figure 8 illustrates Erich Jantsch's structured rationalization of creative action [69, p. 16]. Dotted arrows indicated feedbacks. In the traditional sense, the emphasis on system-effectiveness appears here at the strategic-tactical levels, at the nuts and bolts level. It is also at these levels where much of the traditional management sciences and operations research methods are thought to be potentially effective aids in making operations cost-effective. On the benefit side the emphasis is traditionally mainly at the outcome oriented system-effectiveness levels at about a strategic level. If one is expanding away from "local" economic effects and includes social and political effects, the benefit considerations may have to penetrate through the policy level into the considerations of the basic value system of a society. The

Figure 8. Erich Jantsch's Structured Rationalization of Creative Action



system approach of Jantsch provides indeed an interesting logical framework for such purposes. The inability to account for social and political impacts may be one of the key problems in technology assessment [70,71] apart from the limitations of the traditional benefit-cost analysis and its inappropriate economic foundations. For example, the recent and current efforts of OECD tend to move in the direction of an overall system approach for technology assessment [72,73].

The level of program management is an aspect of tactical or operational planning. The program management involves implementation or allocation of resources to programs, integration of effort, measurement of effort and results, control of progress toward goal patterns within a given time framework. Typically several programs are to be managed simultaneously. Not only should each program be managed efficiently, but all the projects should be treated simultaneously as an overall system benefiting from all possible synergies developed between them. In a multi-program environment one can talk about a Planning-Programming-Budgeting System (PPBS), where specific resources are allocated to and between a number of programs, each with a specified budget, and with results measured over time for each and all programs [75, Chapter 6]. Figure 9 illustrates the setting of a multi-program management system at its operational level in relation to the overall planning system. This multi-program operational level of management is supposed to be consistent with the principles of management by objectives and results [77]. The "cost-effectiveness" of allocating limited resources under a specified overall budget to the various programs in the system over time is related to the "cost-effectiveness" of each program in the system, but with the important non-linear overall effort to generate synergies between the programs themselves, and between them and the whole management system. The budget and cost control is an important financial aspect of the whole system and of each and all the individual programs. On a benefit side, the results over time for each and all programs measure the movement of these programs toward the selected goal pattern. In a governmental effort the benefits of these results need not and often cannot be related to the economic efficiency measures of a market economy; in fact, these results relate to such policy dimensions as those of national survival, social and political factors that cannot be directly measured in terms of purely economic determinants, and cultural dimensions of a very long-run nature. Therefore, a strict insistence on a purely economic benefit-cost criterion for each project may not be possible nor desirable.

On the cost side, the budgetary aspect of project management provides a financial dimension of control. Typically, this must be augmented by a scheme to control performance and progress of the project in the framework of its planned performance structure. A variety of program planning and control techniques have been developed over years in the areas of Management Science and Operations Research. A well-known illustration of such a technique is the Program Evaluation and Review Technique with its Critical Path and PERT Cost extensions. Figure 10 illustrates the PERT-CPM-Cost concept properly scaled over time. The heavy path in the PERT diagram illustrates the critical path (CP).

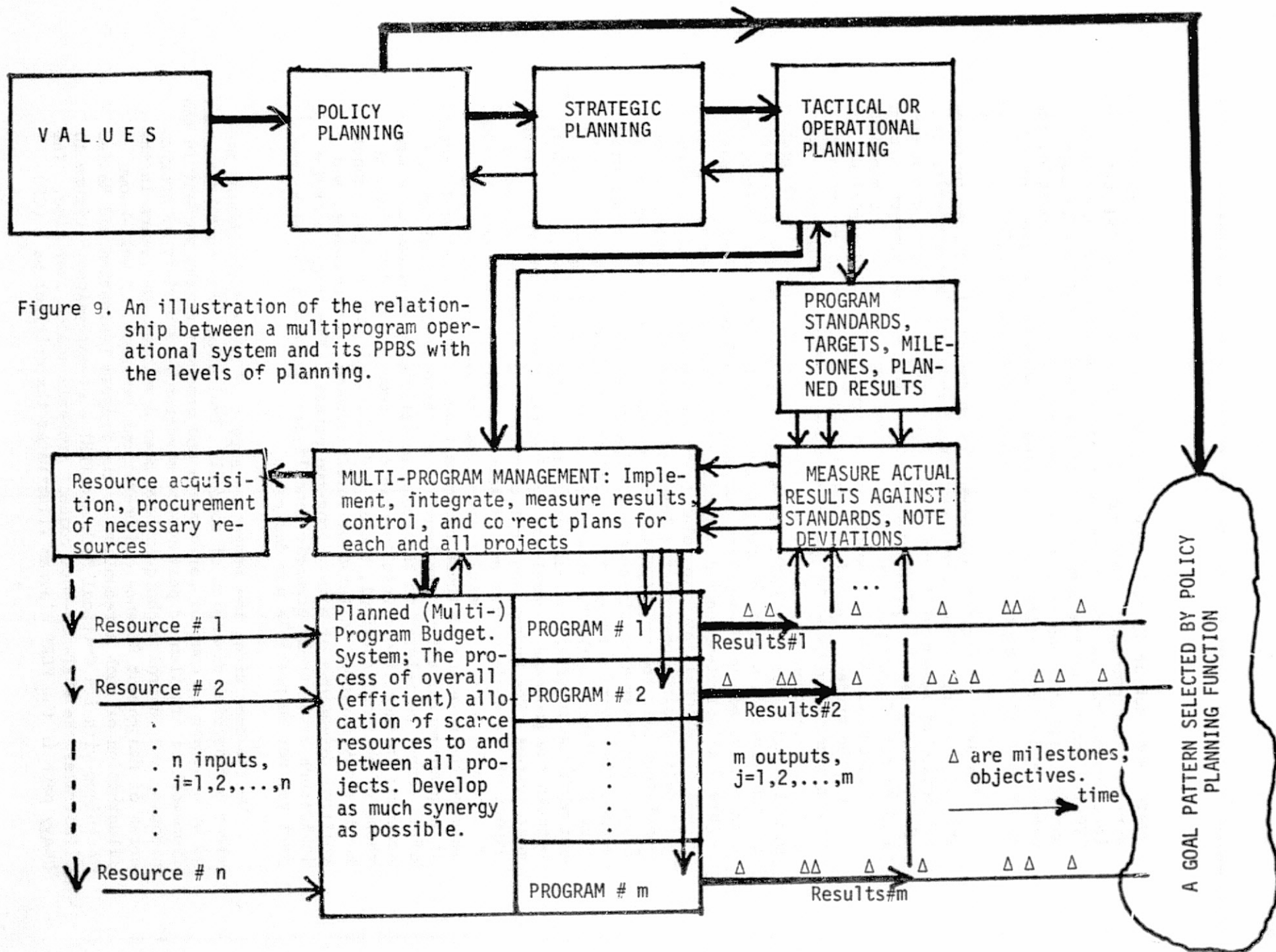


Figure 9. An illustration of the relationship between a multiprogram operational system and its PPBS with the levels of planning.

Events represent specific objectives to be achieved and necessary for the overall progress. Tasks or activities are represented by lines connecting events: thus one gets a directed graph sequentially in parallel progressing from various events to subsequent events. As the PERT diagram was scaled over time, one can readily develop also its GANTT MILE STONE diagram. Further, each branch in the PERT diagram corresponds to an activity or task whose cost can be imputed over time over its duration. These costs can be added up to a total cumulative cost or budget schedule for the program. Such a total cost or budget schedule gives then the aggregated cumulative cost control standard for the program manager.

It should be noted in this connection that specific planning and control methods and tools may or may not be appropriate for a program depending on its specific nature. PERT, for example, may work well for a development program where activities and events can be quite well defined in terms of known technology. It is likely to be totally useless for a basic research program where tasks and events are at best very fuzzy or ill-defined, and the time to accomplish an imagined end result has a very high degree of uncertainty. It would be very interesting to investigate whether such techniques as PPBS are really appropriate or, perhaps, very distorting for systems of programs in the areas of pure, fundamental and exploratory research. Some private companies have taken the very long-run point of view of allocating a fixed percentage of their sales to basic research, and then writing it off as a "cost of business". Perhaps, public sector should try to do something similar: write off a fixed percentage of public budget for basic research as a "cost of long run political survival".

With the preceding overview of planning-decision levels it seems appropriate to discuss the respective supporting approaches and methods for these tasks. Again, the subsequent discussion is mainly based on the work of Erich Jantsch [68, Chapter 2]. In Figure 4 in the right hand margin we find the supporting approaches and methods as follows:

POLICY SCIENCES: Jantsch considers policies as normative expressions of future states of dynamic systems, whereby policies can be formed meaningfully only if the boundaries and structures of the system can be clearly perceived. Further, the roles of institutions are given in the context of these systems to which the institutions and their instrumentalities belong. Per Figure 8, "policy sciences deal with the horizontal unfolding, as general instances of human activity, of forecasting, planning, decision making and action at the policy level.... ensuring the human action model in structuring rationality at the policy level [68, p. 18]." The supporting disciplines and interdisciplines include philosophy, psychology and social psychology, sociology, law, political economy, anthropology, systems sciences, and others. The main thrust is on system design, policy design, design of institutions [68, p. 18]. It should be noted in this connection that any institution that participates in the design of a society is a political institution. And to the better or worse, any system of interactive institutions participating in planning of a society is an institutional

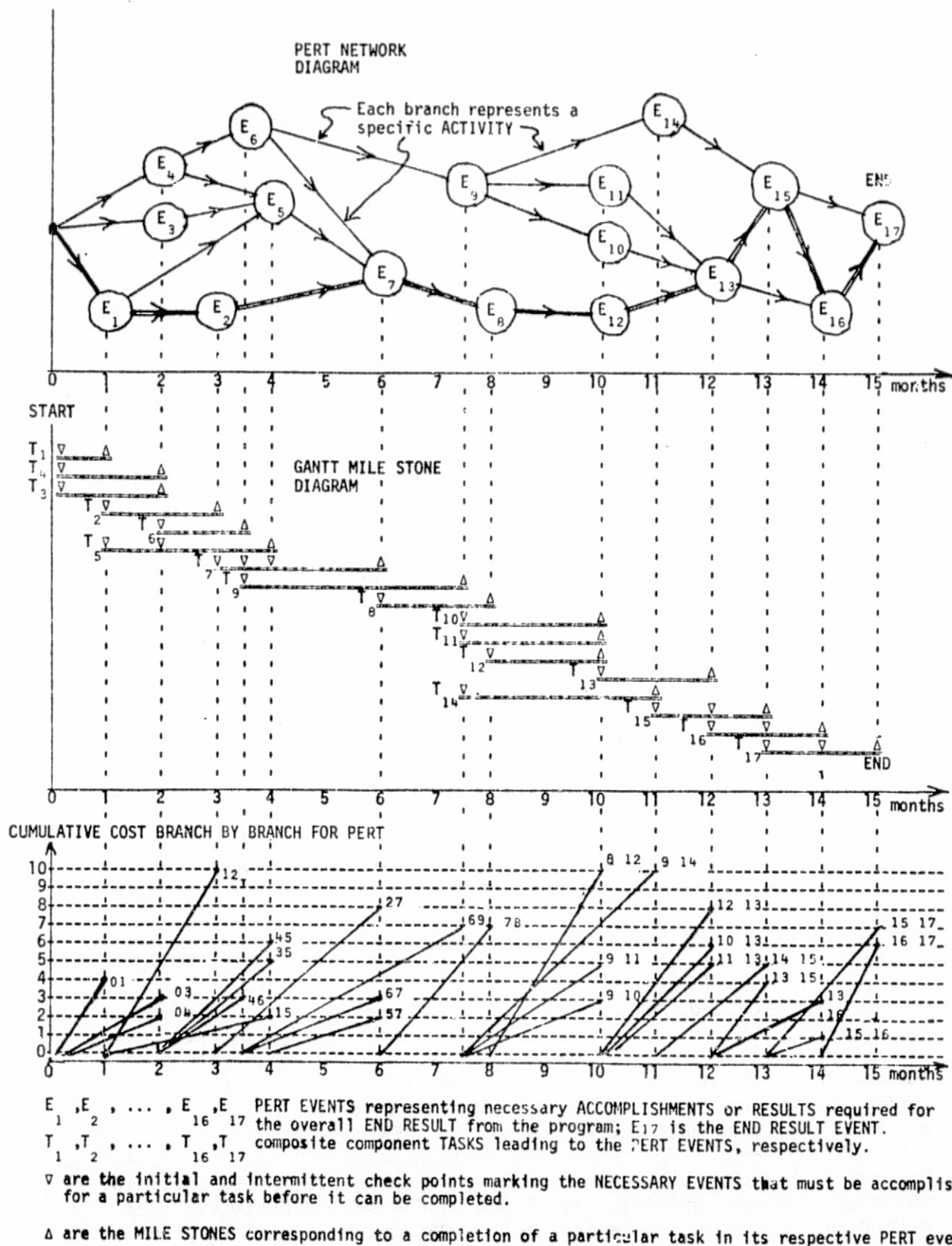


Figure 10. An illustration of a PERT-GANTT-ACTIVITY COST planning and control system for a program.

and political complex (e.g. the "industrial-military complex" of Eisenhower). Political power is an essential object of policy sciences. Any subject matter that relates to the formation of a public policy is a subject matter of policy sciences. Any aspect that affects the planning and design of a society is a subject matter of policy sciences. Policy sciences tend to be synthetic in nature.

STRATEGIC OR PROSPECTIVE SCIENCES: According to Jantsch, these sciences deal "integrally with the conception of possible activities, their implications for system structures and system-effectiveness, and the creation of instrumentalities [68, p. 19]." The disciplines listed here are among others: sociology, technology, system sciences and simulation, decision theory, a variety of integrative socioeconomic areas (e.g. PPBS), an assortment of possible generalized 'social cost-effectiveness' approaches such as Total Assessment Profile discussed here, and so on. In a contrast to the synthetic nature of policy sciences, the strategic or prospective sciences emphasize analysis: System analysis, policy analysis after policy forming, need analysis, institutional analysis, market analysis. These sciences support social and technological innovation.

MANAGEMENT OR ADMINISTRATIVE SCIENCES: The supporting sciences for the tactical or operational level of planning and control the management or administrative sciences provide efficient forecasting, scheduling, the changing of system variables, determination of economic efficient modes or "optimal" modes of operations, and so on. At the operational levels the supporting disciplines are those of appropriate economics, benefit-cost analysis, managerial and engineering economics, operations research, administrative sciences, statistical quality control and reliability sciences, and so on. The emphasis is on optimization and expansion of actual activities, of system variables, resources, markets and operations in general. The results sought for are conservation of resources, systemic structures, and improvements in system throughput efficiencies.

It should be noted here that benefit-cost analysis belongs primarily to the tactical or operation level as it is traditionally conceived.

As the public budget and budgeting is an important aspect of allocation of resources and the respective fiscal and financial control of public sector activities, it deserves some discussion in relation to the previous overview of planning-decision processes [74,75,76,78]. This will be done next.

3. REMARKS ON THE EVOLUTION OF PUBLIC BUDGETING

In the United States the percentage of public expenditures of total GNP has gone up over years indicating the growth of the relative importance of the public sector in economic affairs. In 1929 the percentage of local, state and federal expenditures was 9.6 percent. In 1960 this

percentage was 27.1, and since 1967 it grew from 30.6 to 33.7 percent in 1970 [79, p. 92]. In 1971 the U.S. Bureau of Budget gave the following thirteen functional categories for the expenditures of the federal government:

1. National defense
2. Income security
3. Interest on debt
4. Health
5. Commerce and transportation
6. Veterans benefits and services
7. Education and manpower
8. Agriculture and rural development
9. General government
10. Community development and housing
11. International affairs
12. Space research and technology
13. Natural resources

In 1970 the federal government expenditures were 206.3 billion dollars while those for the local and state governments were 107.5 billion dollars. The 1970 GNP was 931.4 billion dollars. In the local and state sectors the expenditures were categorized as follows:

1. Education
2. Police services
3. Fire protection
4. Prisons
5. Sanitary services
6. Health and hospitals
7. Public assistance and relief
8. Highways
9. Natural resources (conservation and recreation)
10. Public utilities
11. Administration
12. Other

Of these items the expenditure on education was largest, comprising 40.3 percent in 1968 [79, p. 96].

The years of World War II represent historically the peak years of federal expenditure as a percentage of GNP, being 35.3 percent in 1942 and 39.6 percent in 1945. This era was, indeed, a test of "cost-effectiveness" of the extensive defense operations required to carry out the war. The large war effort was carried out to a great extent by a brute force approach to pump resources to support the military operations. "The warfare operations during World War II present many examples where the mission success was backed up by tremendous inventories and costs because there was a gross lack of reliability (and system-effectiveness) of the required supply components. it was reported that some 60% of airborne equipment shipped to the Far East by the U.S.

was damaged on arrival; 50% of spares and equipment in storage became unserviceable before use. The shipborne equipment was inoperative more than 2/3 of the time. The U.S. Army reported that 75% of its electronic equipment was out of commission or under repair [80, p. 2]." While the political factors may far outweigh any economic consideration as long as there is an adequate availability of required resources, there are lessons to be learned in finding out more efficient and responsive ways to meet the operational requirements of defensive or offensive operations. While the policy planning may call for survival, gains in the relative position in a power struggle, and the preservation of social, economic and cultural values, there really remains the strategic question how to do all this with "least effort".

It may be the case that the performance in the private sector is not necessarily so great, not so potent as claimed by a myth based on a, perhaps, unrealistic economic theory. Nevertheless, this does not provide an excuse for the public sector to be sloppy in choosing goals and allocating resources to reach these goals.

It may not be so surprising that the apparent or real "inefficiencies" of the World War II era prompted some real concern for increased efficiencies in public sector operations. In this sense, the experiences of the World War II era may, indeed, be a justified threshold concern for the subsequent era of "system effectiveness". It is considerably less clear why there was so much concern for economic efficiency (as distinct from social and political efficiency) of government during the depression years preceding World War II, when the society was idling huge amounts of productive resources as though hypnotized into a paralysis by a queer myth of economic and social thinking. It is here where Pareto's sociological notions, Veblen, Arnold and others may have something interesting to say. It is here where political and social factors start overriding purely economic considerations. What does "economic efficiency" mean when a society is filled with idling economic resources? Thurman Arnold candidly points out the surveys on paramount problems of the United States, The National Economic League [81, pp. 103-107]. The "efficiencies of Government" rated as follows: eleventh concern among thirty-five in 1930; tenth concern among thirty-two items in 1931; first concern among thirty-nine items of ranked importance in 1932; first concern among forty ranked items in 1934; second concern among thirty-six major ranked items in 1937. These rankings illustrate how the "efficiency of government" remains in the foreground even though the society is filled with unemployed resources whose employment could immediately improve the economic efficiency of the public and private sector. It is not a Walras-Pareto general equilibrium setting, nor efficient one thereby for the private sector.

The emphasis on the "efficiency of government" is deeply rooted in American political thought. In a dual sector economy the efficiency of government is somehow compared to the efficiency of the private sector: if the competition is sufficiently perfect, if the market mechanisms

would be sufficiently free of distortions, etc., then the test of the efficiency for private sector would be given in terms of such market interactions. The myth of the criteria of efficiency for the private sector would vanish if some or all the numerous conditions for the "efficiency of the competitive market economy" are not, in fact, satisfied by the actual operation of such an economy. The public sector escapes the measure of efficiency by "market mechanisms". In the old economics, its impact on private sector is through taxation, competition for scarce resources and other "externalities" that distort the efficiency of private sector, and generates social costs thereby. In a contract, there is the possibility of social benefits generated through "externalities" that cut production costs and unit costs of resources for private operations.

[8, p. 35]: As the governmental activities are organized in accordance with the budget principle the objective test of efficiency which is traditionally assumed to be present in the market economy is lacking here. There are no tangible and self-enforcing economic criteria for evaluating efficiency in the public sector. There is a great deal of fuzziness in the use of the term "efficiency" in connection with governmental activities.

For private sector firms financial efficiency is traditionally measured in terms of net profits, a measure which does not apply to government. Further, in the private sector, operating efficiency can be quantified in terms of product output per unit of factor (labor and capital) input. Thus, increases in efficiency are measurable in terms of increases in productivity. Efforts to apply these concepts to government operations have not proved successful.

How then should we treat "efficiency in Government"? Decisions affecting the distribution of government expenditures could be treated as political decisions, governed by noneconomic factors. Political judgments could be treated as value judgments but economic judgments might be treated as purely positive considerations. One could argue that economics is concerned only with means and not with ends, or that political factors are exogenous to the economics under consideration [74, p. 35].

Apart from the possibility that market economy is far from perfect and might not therefore reflect with any assurance the efficiency of private enterprises, there still is a persistent effort and need to make governmental operations accountable in terms of some measures of efficiency. In post World War II years there has been an increasing emphasis to shift from governmental "line-item budgeting" toward "performance budgeting". Thus performance budgeting can be most appropriately associated with a budget classification that emphasizes what government does, rather than the items which government buys. Performance budgeting emphasizes the means of accomplishment rather than accomplishment itself. The classification required must therefore be very different from one based on items of expenditure classified

according to type. The item classification shows what government purchases but not why: It does not show the nature of governmental programs, or results achieved under those programs [74, p. 133].

The performance budgeting thus shifted the emphasis to programs and program accomplishments. A mere line-item object classification had no handle on what government was doing and how it was performing. Once programs and performance became emphasized, the next step was to move toward "cost-effectiveness" of government programs. Not only was performance singled out but it was to be "optimized" by some objective criterion: minimize cost for a specified output or maximize output for a given budget. The Taft Commission on Economy and Efficiency in 1912 stressed the importance of objectives oriented budgeting. However, the significant attempts in this direction appear much later when the U.S. Department of Agriculture in 1934 stresses the project budgeting and activity schedules. About the same time T.V.A. initiated a budgeting procedure stressing program classification and accomplishments. In 1946 Navy Department presented its fiscal year 1948 budget along the lines of traditional object classification but also in terms of program classifications. In 1949 Hoover Commission in its report on Budgeting and Accounting stated: "We recommend that the whole budgetary concept of the Federal Government should be refashioned by the adoption of a budget based on functions, activities, and projects: this we designate a "performance budget" [74, pp. 134-135].

In 1949 amendments to the National Security Act it was provided that the budget estimates of DoD "...shall be prepared, presented, and justified, where practicable, and authorized programs shall be administered, in such form and manner as the Secretary of Defense, subject to the authority and direction of the President, may determine, so as to account for, and report, the cost of performance of readily identifiable functional programs and activities, with segregation of operating and capital programs [74, pp. 135-6]." The Budget and Accounting Procedures Act of 1950 (P.L. 784, 81st Cong., 2d sess.) further reinforces the performance budgeting concept and the principle of accounting by objectives and results of programs.

The McNamara era brought in an accelerated emphasis on the extensions of the performance budgeting concept: it transferred it into a multi-program environment emphasizing an increased capability of analysis, PPBS process and the respective management information systems. Secretary of Defense Robert S. McNamara's statement before the Committee on Armed Services on the Fiscal Year 1965-69 Defense Program and the 1965 Defense Budget, January 27, 1964 clearly spells out this extended direction on an increased performance oriented systems approach to DoD programs. This was followed by President Lyndon B. Johnson's statement that "A very new and very revolutionary system of planning and budgeting (should) be instituted through the vast Federal Government [75, Chapter 6]." The power of the 1947 National Security Act amended in 1949 and 1950 had given to the Secretary of Defense an avenue to push for an extended concept of the performance budgeting: PPBS.

At this point it is interesting to quote Jesse Burkhead, Maxwell Professor of Economics at Syracuse University: "In the realm of practice, contemplate the wreckage of the Planning-Programming-Budgeting System. Initiated by economists at RAND in 1948, transferred to the Department of Defense in 1960, expanded to the entire range of civilian departments and agencies in 1965, by 1970 it was quietly relegated to obscurity. We learned that economists cannot measure government output in discrete units [82, p. 11]."

The concept of performance budgeting and its extensions toward PPBS is important for benefit-cost analysis in its traditional sense. The nagging question is: how sufficient is economic theory in its policy, strategic and tactical implications for an adequate foundation of benefit-cost considerations in the private and public domains?

4. COMMENTS ON RELATIVITY OF PLANNING-DECISION PROCESSES

Figure 8 conveys the message that a policy-strategic-tactical planning process is vertically and horizontally two-way interactive, iterative and adaptive system subject to societal learning processes. Further, it conveys the message that values and norms are subject to the dynamics of actions and reactions in the overall setting. The concept of action generating reaction which in turn generates action, etc. is the basic concept of Newtonian mechanics. The equation of motion describing the resulting path is subject to a set of assumed constraints. The dialectics of Hegel and Marx is an extraction and modification of this concept of action and reaction. Galbraith with his view of countervailing powers further promotes this idea. The "Total System Dynamics" of Jantsch (Figure 8) may be an attempt to seek for a dynamic equation of societal motion but in an adaptive sense subject to further identification and modification through learning.

There are major philosophical differences between the Newtonian view that makes "reality" or "real world" independent of the observer, and the views of Einstein and modern quantum mechanics which bring the observer into the system as an integral part of it. In the ancient Buddhist philosophy, observer, observed and the universe where all this happens are inseparable, and can be understood only if the totality of all this is understood. Further, there is no unique way of separating observer from his environment nor what is observed from the observer and the environment. The situation must be analyzed as a whole, as a totality. General systems theory may be considered in this sense as a reaction to the "atomistic" philosophies of the traditional western sciences.

It promotes also a suggestion that "policy sciences", "strategy sciences", and "management sciences" may suffer from relative compartmentalization, fractionalization, "local" isolation. They may tend to breed fads rather than a serious and genuine way of attempting to look at the "whole" of it all. The large order imaginative, logical and

empirical "pattern recognition" process for very long run processes possible for a society and its environment in an interaction may be an art forcing out certain solutions in the direction of some imagined goal patterns. But such an art requires political power, the power to influence the actions and minds of individuals and social groups to move in the suggested directions. In this regard, the exercises of planning without political power may turn out to be a mere ritual. The real possibility that a planning-decision process is merely a ritual without any significant connection to the exercise of power cannot be overlooked, for example, in connection of such considerations as the benefit-cost analysis of a program. One of the tasks of a serious political process is to filter out irrelevant dissipative spurious effects from planning-decision processes, and direct the political action toward basic relevant issues. This involves intimately the notion and respect for a basic value system and the respective norms, which provide a reasonable reference for a contemporary policy and strategy formulation for the "best possible" anticipated direction of motion of the society.

Suppose that we are somehow able to identify and recognize a pattern of interactions, which we call our "society" or "system of social action", against the overall background of our perceived and contemporarily understood "universe", which might be also called the "general environment" of our "society". It is important to note the relativity associated with our conception of the "universe": it is subject to our learning and state of knowledge, our attitudes and values, to our contemporary consensus on what is "objectivity", "reality", to our current cognitive perception of it. For example, in terms of history of science it is hard to pinpoint any absolute "real world" independent of our way of perceiving the "universe".

Suppose that we further identify and recognize an "event" or "entity" against our perceived "universe", an "event" or "entity" whose impact upon our "society" we somehow desire to evaluate. Typically, this "event" would overlap our "society": there would be some degree of commonality. Now, the way we perceive the "universe", "society" and the "event" conjointly will be a mutually interactive concept where we as the "observer", the perceived "universe", "society" and "event" are in unison where it is at best arbitrary to break up these four "entities" into separated subsystems. It is relatively easy to set up psychological experiments to demonstrate the interactiveness and interdependence of this holistic "gestalt" nature of this situation. Figure 11 illustrates this setting of mutual (and non-linear) interactions for our attempts as "observer" to recognize and understand what is going on. If we would adhere to the traditional "atomistic" approach with its notion of superposition of individual subsystems into a system, we might thereby generate constraints that would reduce the "bounds of our rationality". The other approach would attempt to sense the "whole" of it all, and then attempt to decompose it in a highly interactive manner to a structure of sub-patterns which in conjunction of the holistic situation would allow us to account for and predict processes, interactions and impacts.

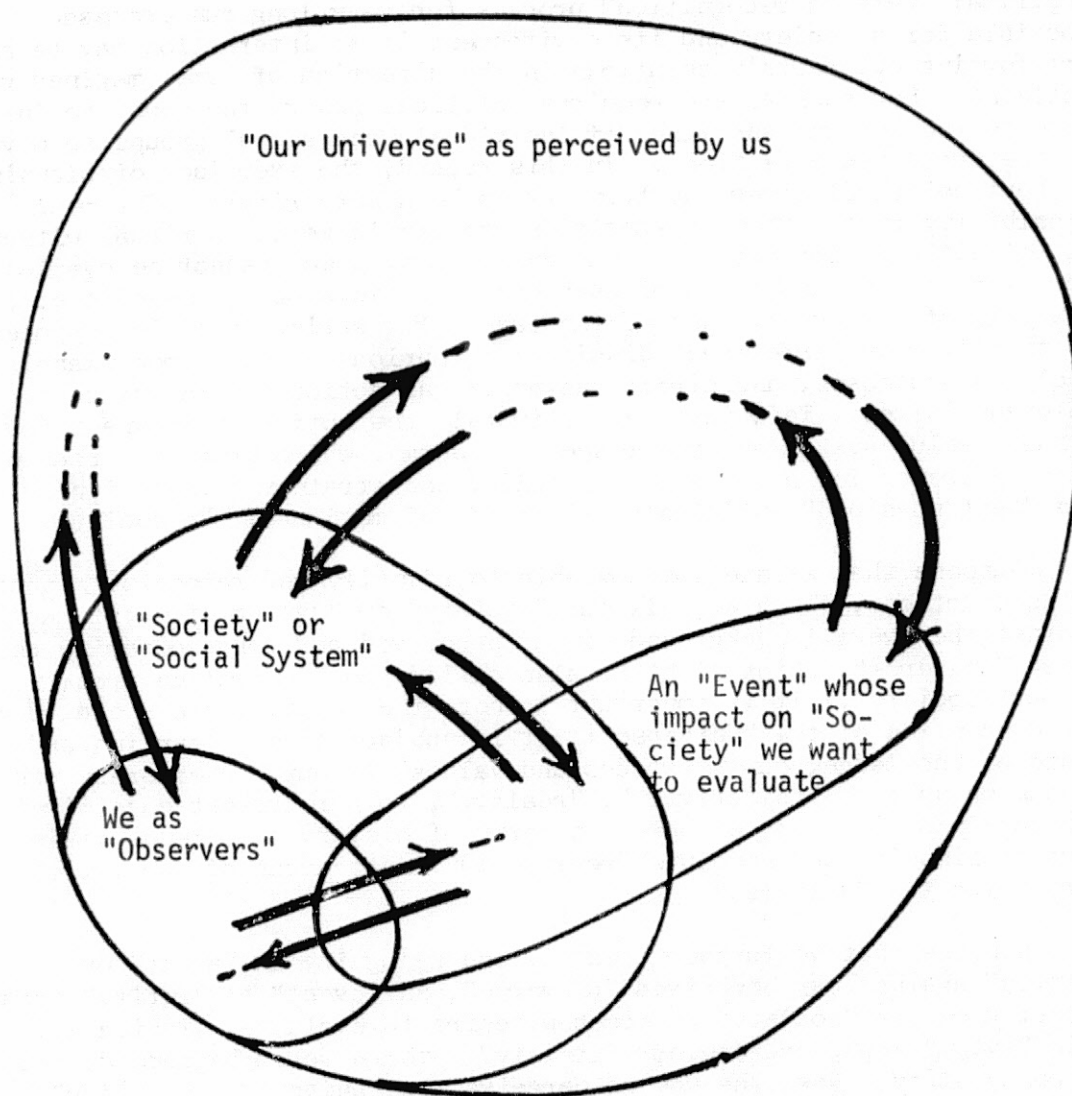


Figure 11. An illustration of a Gestalt setting for Social Impact Evaluation. Arrows indicate structural interdependences, interactions influencing the process of pattern recognition. These interdependences are typically non-linear.

A simple illustration of the non-linearity and interdependence of a pattern of "events" with respect to the observer is indicated in Figure 12. Let the "square" be the "universe" perceived by you as the "observer". Let the pair of "parallel lines" be the "society". Now introduce an "event", a radially outward radiating pattern of straight lines, centered at the center of our "universe" as indicated in Figure 13. The impact of this new event affects both the "universe" and the "society" as perceived by you as the "observer". In both cases only straight lines were used, and both figures above are atomistically superpositions of straight lines. However, to you as the observer the impact of the event is non-linear, not explainable by the simple superposition of straight lines. Some people call this "optical illusion", but it is not really an illusion but a "property" of an observer in an interaction with what is observed by him. This kind of a non-linear interdependence of an observer and observed can be found with respect to all known human sense perceptions, affecting his pattern recognition processes, and, ultimately his conceptions and "models" or "maps" of his perceived universe and events in it. Since societal value systems and norms are ultimately those generated by human beings reflecting their perceptual and cognitive behavior, and their visions of their universe and events in it, this gestalt aspect of observer-observed-universe can be assumed to creep in as an important dimension of policy planning.

General Systems Theory attempts to move away from the "naive" atomistic approach to human problems [83,84,85,86,87,88]. Many authors think that it will help considerably policy sciences toward a more relevant and meaningful total assessment of impacts of either planned or accidental events. There are several definitions of a "system" [88, pp. 25-31]: To von Bertalanffy, "A system is an organized or complex whole.."; to Rapoport, "A system is, roughly speaking, a bundle of relationships"; to Ackoff a system is "any entity, conceptual or physical, which consists of interdependent parts"; to Martin, Jr. "A system is an assemblage or combination of things or parts forming a complex whole"; and to Beckett "A system is a collection of interacting systems". Churchman notes that "The system is always embedded in a larger system [89, p. 75]." The closure may be then our ultimate perception and conception of the grand universe. It still remains to be seen how fruitful general systems theory will be in taking us effectively from our "atomistic fixations" into a deeper understanding of the gestalt nature of the observer-observed-universe setting.

5. ON THE QUESTION OF ISOLATING ENTITIES AND INTERACTIONS IN ECONOMIC - SOCIAL - POLITICAL IMPACT EVALUATIONS

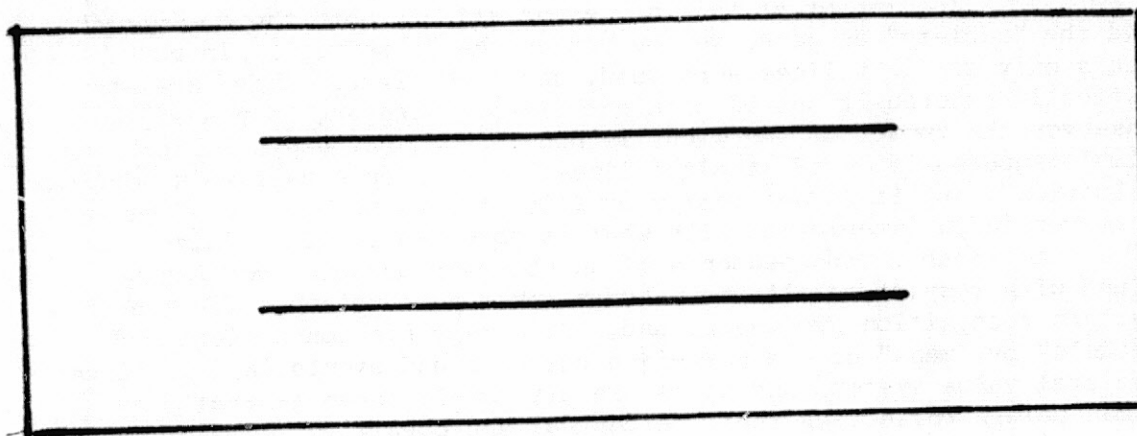


Figure 12

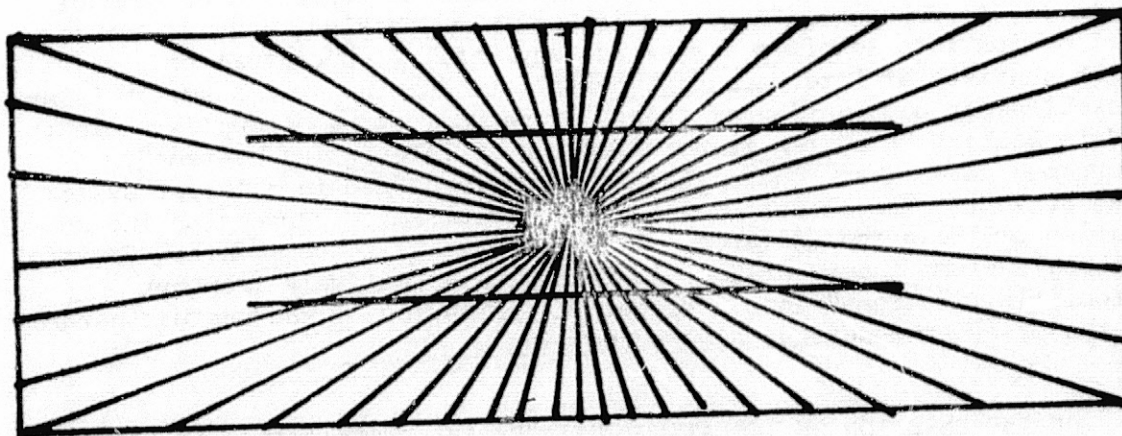


Figure 13

Figure 14 illustrates a conception of a societal planning-action process. The policy and strategic planning is based on the values and norms of a society. These planning processes generate tactical plans and operations resulting in an action generating planned impacts on the societal process. Black arrows indicate direct feedback processes through the planning processes and upon the value system. In addition to the planned impacts there are unplanned impacts generated by unforeseen internal and external events. These impacts change the societal process and the structure of the society, feeding back among other things through exercise of political power and action in forms of revealed and forced preferences to modify the values of the society. Planned and unplanned events modify the society which in turn modify events. There is an important question relating to the identification and accountability of planned and unplanned impacts as well as the nature of the related interactions and feedback processes: is it, indeed, possible to identify and single out some relatively invariant aspects of social behavior? A societal process can be thought to be among other things an adaptive learning process, not necessarily stationary nor stable over time, nor easily detectable among a variety of spurious effects. For example, in economic modeling, certain kind of consumption and investment behavior is assumed, tested out through econometrics, and adjusted with best estimates in an environment of a "noisy" data. However, this does not make an economic model unique in the sense that it would be the only or best possible model among all possible models. In fact, such a model may turn out to be poor in actually predicting economic behavior.

Especially in social sciences there is a danger of relying excessively on mechanistic models which do not account for dynamic adaptive and learning processes and a variety of "dislocational" effects in the structure of a social process. For example, a planning process may restructure a society in some major way; and this in turn may restructure the planning process in a significant way. How could we predict, identify and evaluate such impact chain reactions? In this sense a society is much more like a living organism than even a rather sophisticated mechanistic machine. It can have all kinds of behavioral peculiarities not easily predictable in a complex setting. In fact, many social and political science studies seem to be of the post mortem type: a set of data is explained in terms of factors and relationships perhaps good for that particular explanation but not necessarily good for predicting future behavior. And as the society keeps changing, a model of social behavior must be continuously tuned in with recent data. Further, even such tuning will not suffice for a predictive model if there are various "dislocational" effects which the model cannot handle. In contrast to a mechanistic model a social behavior model for predictive purposes tends to be empirically oriented, data oriented. Econometric models are good examples of this. They require a respective information system in order to keep them tuned up to current "social indicators"; they must be adjusted continuously to the recent information so that we can hope to predict future economic behavior a bit more reliably and accurately. If various social and

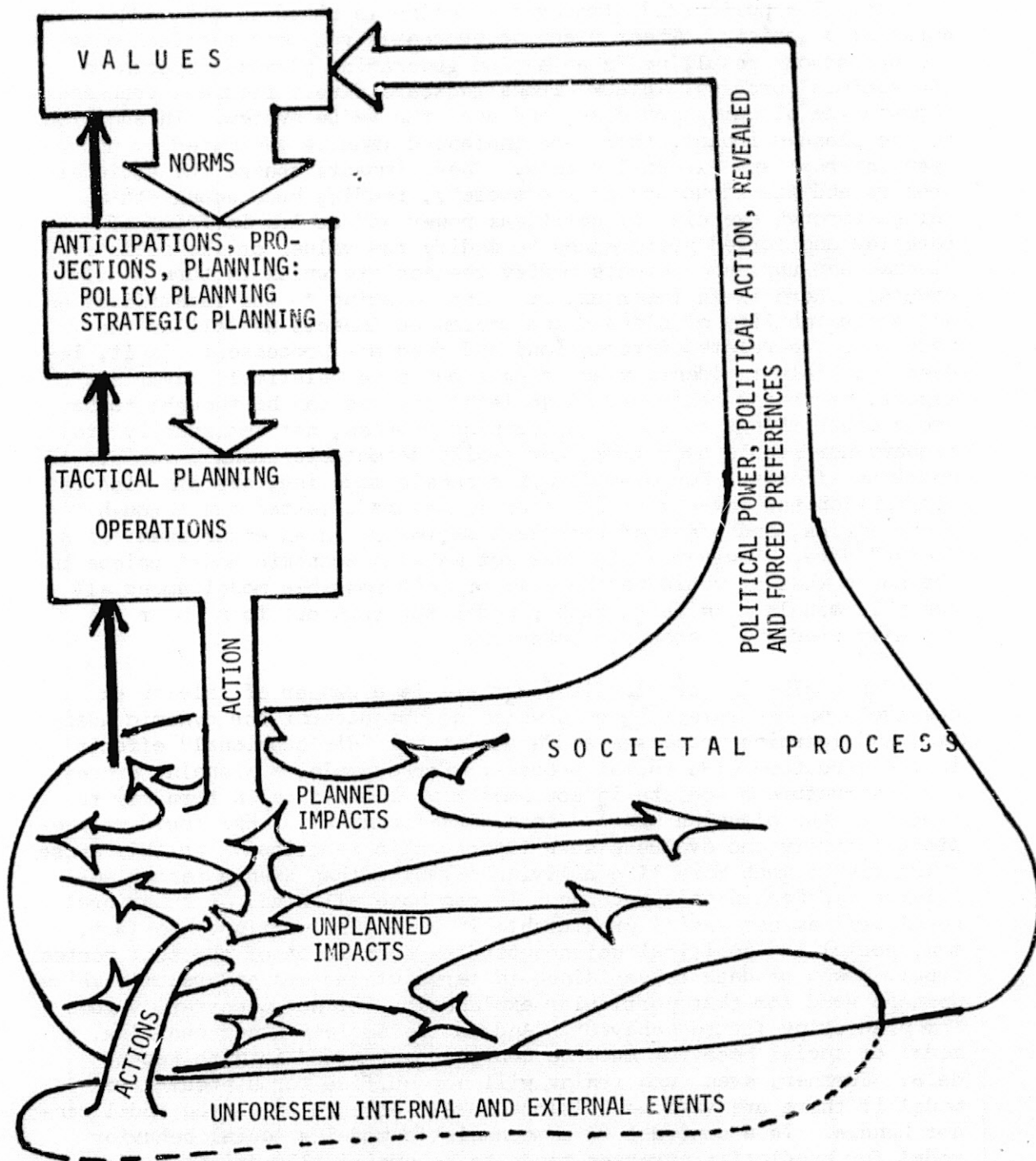


Figure 14. A conception of a societal planning-action process

political dimensions are added over and above the economic ones, then the situation can be expected to grow in complexity and requirements for information management. Yet there is a growing feeling among many that economics - as the queen of social sciences - is even less sufficient than ever before as a way of evaluating even economic impacts of public projects, to say nothing of social and political impacts.

There is then the serious question how to develop an effective and relatively simple model of social action that could be somehow anchored to some relevant and reasonably sufficient set of at least "nearly invariant" aspects of social behavior. It would be possible to use several relevant models conjointly to estimate various aspects of economic, social and political behavior for the impact evaluation in such a manner that a variety of measures and indicators complement each other in giving to a planner and a decision maker a better feeling in terms of an assessment profile not only of economic but social and political impacts of a program. It is likely that these measures may have overlapping effects. Such redundancies may be desirable for increased reliability of the total assessment process. In social sciences we may have to learn to live with only partial identification and isolation of relevant entities and interactions. But if several "less perfect" structural models are used conjointly, the results may be better than using a single "more perfect" instrument.

6. COMMENTS ON ECONOMICS AS A POLICY SCIENCE

Throughout human history the element of economic power has been one of the major dimensions of power politics and, therefore, a major perspective of policy making. The survival and relative power of people and their societies rests on developing and accessing means and resources for production. Economic practices and theory have institutional and cultural colorings and bias. There are strong undertones of normative implications what "ought" to be done versus a positive approach of what actually might be going on.

Most social and economic theories referring to the future, such as limits to growth models, zero population growth models, zero economic growth models, doomsday models, etc. seek to condition our political attitudes. Such models or such futurism need not be pessimistic but rather a realistic recognition of a "possible future" for a policy consideration among other alternatives. In fact, an intelligent "growth management" (as distinct, for example, from Keynesian "demand management") may be a very appropriate long-run attitude.

The so-called Neo-Keynesian Synthesis illustrates a great triumph of economics as a policy science. Its great strength rested in its effective combination of measurement, theory, and policy prescriptions. It saved the "private sector" with its imperfections from the Marxian steamroller by allowing a "public sector" to remedy these imperfections.

Nevertheless, it remained perhaps at a too aggregated level as somewhat "mechanistic" model incapable of pinpointing out sources of economic, social and political sources of impacts at some deaggregated or "micro-economic" level. A variety of societal "dislocations" can kill the operational significance and relevance of an accepted model or theory adopted for policy purposes. Further, a model or theory that is successful over a period of time tends to acquire in the eyes of its users an aura of a closed system. This illusion can easily arise when the policy makers neglect the possibility of institutional and historic shifts in societal processes thus making a particular model obsolete for its intended use.

While the per capita average real income kept increasing over the few last decades, since 1965 it has been a continuous downhill for economics as a "policy science". The ability to understand the economic behavior of the "real world" and the ability to make sensible economic policy prescriptions has been deteriorating fast over the last decade or so [82, p. 16].

Economists have identified under the heading of "Neglect Tasks" some basic defects of the "old economics":

1. There is really no theory to income distribution. A reason for this is the classical myth that we cannot "scientifically" compare individual utilities or preferences (a rather queer notion in the context of social psychology). If we cannot (or, dogmatically are denied the possibility) to construct an overall social welfare function, then we have no means really to define a socially acceptable income distribution. The "individualistic" or atomistic classical economic theory allows only Pareto-optimality. A. K. Sen points out that "...there is danger in being exclusively concerned with Pareto-optimality. An economy can be optimal in this sense even when some people are rolling in luxury and others are near starvation as long as the starvers cannot be made better off without cutting into the pleasures of the rich...[82, p. 17]."
2. The second problem area in economic methodology is the normative versus positive economics, where the former includes by definition value judgments and the latter is restricted to the rational specification of outcomes. If one makes the assumption that inter-personal utility comparisons are not "scientific" and must be denied (Lionel Robbins, 1932), then social normative value statements are denied. That is, collective value judgment cannot dictate individual values: a peculiar but perhaps politically and culturally unrealistic assumption.

3. The third problem area that has plagued (western) economic theory is the absence of an economic theory of the state and the respective definition of property rights. A multitude of prescriptions exist about what the state should do or not do, each derived from an accepted neo-classical piece of economic analysis. But this is not an economic theory of the state.

Among other things, the economic theories for the development of less developed countries have been, by and large, failures. The income accounting schemes for the understanding of economic development have been incomplete or inadequate even for the developed countries. There are some important questions relating to the adequacy and meaning of macroeconomic production functions to explain growth processes. There are some real problems associated with traditional definitions of factors of production. But perhaps worst of all, the current co-existence of rampant inflation and high levels of unemployment is an "uncomfortable fact and an intellectual riddle (Kenneth Arrow) [82, p. 19]. "That economics is in an uneasy state is now widely recognized (Stanley Wong)." That also means that policy making is in an uneasy state. Quoting Burkhead, "...the wreckage of neo-Keynesian demand management has not yet been replaced by any coherent new theory or any consistent policy prescriptions.... The crucial issue is not how to plan but for whom do we plan [82, pp. 20-21]." That is not just a pure economic question but a question involving conjointly economic, social and political considerations.

"...economists tend to ignore those social (political) and environmental realities that do not fit their theoretical models....(and).. avoid such issues as the distribution of wealth, accepting it as a given. ..they perpetuate the classical concepts of the free market and the all-knowing, ever rational 'homo economicus', ignoring the ways in which these concepts are distorted by the wielding of power, the manipulation of information, the speed-up of technological change, and the human needs and motivations that lie beyond the marketplace [91, p. 28]." When Arthur F. Burns, the chairman of the Federal Reserve Bank, says that "the rules of economics are not working quite the way they used to," he really questions the prescriptive usefulness of the conventional wisdom (statement before the Joint Economic Committee, July 23, 1971).

In a society highly conditioned by an orientation to a market economics and material values of consumption, the exchange markets oriented economic theory has a high appeal to become an over-weighted dimension of policy sciences. It also thereby tends to replace by its "partial analysis" the attempts to formulate policies from a more "holistic point of view". Aggregated economic models have not given the policy makers enough resolution to pinpoint economic, social and political gaming and power centers. "...humans tend to assign values arbitrarily and then pay measures to collect only those data which conform to prevailing assumptions of "value"....[91, p. 156]." Benjamin Ward notes "the avoidance in economics of efforts to study the moving

target of constantly changing human values and preferences [91, p. 156]." To economics has been given the status of the "queen of social sciences" if not even the status of the "queen of policy sciences". At the present there are serious doubts whether this status is really well earned.

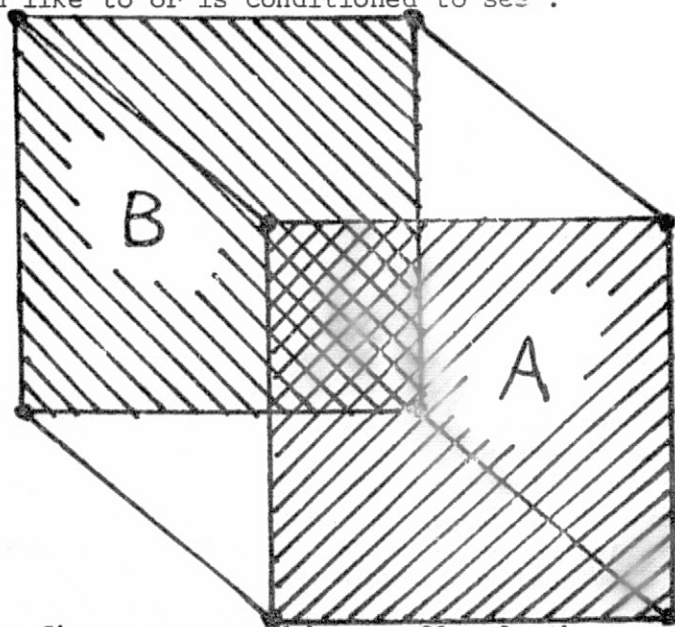
In the current setting of the "policy crisis and economic theory" there are views and suggestions from a variety of "right" and "new left" trying to explain why goals are not properly defined. A defensive reaction from "right" calls for the preservation of the "age-old" and "free enterprise" conception of economics where the tamperings of public sectors merely create distortions and dismay for all. Then, in a middle, there are explanations concerning structural changes, mismatches between supply and demand, dramatic changes in the patterns of international private investment in the last decade or two, and the very high income elasticity of demand for, especially, durable consumer goods, excessive military spending, and the struggles between corporate power and labor unions for the coexistent inflation and unemployment [82, 91]. The "new left" and "neo-Marxists" emphasize class struggle, concentration of corporate power, inequities of income distribution, "colonialism", poverty, urban blight, dehumanization by technology, lack of historic perspectives, the lack of real correlation between financial institutions and the production and distribution of goods, exploitation of people and labor, exploitation of "quality of life" for power of few, the gross neglect of social welfare for splendor of an elite controlling the political power, and so on. Somewhere in the middle or elsewhere are those who are concerned with the long-run future of the mankind, environment, quality of life, plain clean survival, ecological co-existence with the whole nature, and so on. Then there are the ones who point out the racial struggle, racism, genocidal politics and "darwinism"; and, among other things, there are many cultural and religious movements to "save" the world for the good of all (as defined by someone). The imagined economic-social-political settings are many in a multitude.

Economics as a policy science is intimately connected to social, political, institutional, cultural, historic, anthropological, etc. factors. Politically the world may be still divided but strategically and economically it is rapidly integrating. Its institutional forms are changing. While the traditional roles of "nation states" and their assumed national self-determination are still noted principles in practice, such new institutional phenomena as the global multi-national corporations are creating powerful superstructures that are quite capable of crossing barriers of national policies. The "value systems" of societies are subjected to these institutional changes as well as other changes such as those generated by population growth, technological progress, rising expectations of less developed peoples, and the impacts of an increasing competition and attempts to control natural resources. In particular, as noted by Antony Jay, the regional and national economic power of governments may be overtaken by the global economic internationalism of huge concentrated power centers of the multi-national corporations [101]. The policies of such powerful institutions can cut across policies of nation states. This is not necessarily a recent phenomenon of human history. Also, the impact on

values generated by ever new institutional phenomena must be seriously considered in a world of increasing interdependences. The notion of "values" is deeply embedded in the processes of political power and the desires of human beings to survive as much as possible.

7. ON THE "SCIENCE OF VALUES"

Can there really be a "science of values" continuously searching after ever changing human values and preferences [95]? This is an age-old question in seeking for an understanding of man and his destiny. C. West Churchman notes that "... 'Science' is a name for a social activity that has a tremendous impact on all that we do and especially on the policies that we adopt as a nation. As a nation we have to decide what constitutes reliable information in order to decide what we are going to do. Hence, what 'science' means depends, in part at least, on what a whole society or culture takes to be reliable information [102, p. 4]." There is the question what we really mean by "relevant", "objective", "information". A person typically does not look at his world "as it is" but rather as "it seems to be in relation to what he would like to or is conditioned to see".



Consider the figure presented here. Clearly the way we "see" this figure depends not only upon what is in this figure in a setting of its environment but on how we "want" to see it, how we are disposed toward seeing it, how we are conditioned to see it. If we are two-dimensionally disposed, we could see, for example, two squares overlapping and straight lines connecting their geometrically "respective" corner points. If we are three-dimensionally disposed, we could see a cube somewhat from a perspective below facing the front face of the cube, B. Or we might conceive this figure as a cube viewed somewhat from above with a front face A. Therefore, we can have several different visions of this entity, and, correspondingly assign several different "values" to it. Indeed,

we could change our minds about how to vision and assign values to this "entity" rather rapidly as our mood of envisioning it switches from one to another, and so on. What then would be a "science of values" that would provide us some added understanding of our value-behavior with respect to this relationship between us and this object? How could we expand this "science" if you convince me to see this object one way; and I, in turn, convince you to see in some other way? Can we come into some agreement how we collectively "should" see this "entity"? We are back at our holistic problem of observer-observed-environment with adaptive learning processes. Its solution may not ever be found through the atomistic approach of the conventional "sciences" which have also penetrated the so-called "value sciences" and management sciences.

Churchman notes that "...one meaning of the scientific verification of what a man "ought" to do depends on the scientist's way of measuring what he wants to do. If we know what a man wants, that is, if we can measure his values - then we can say what he ought to do....such an "ought" is not necessarily a moral "ought". However, we shall want to see whether we can find a meaning of the moral "ought" once we have satisfied ourselves about the meaning of the moral "ought" once we have satisfied ourselves about the meaning of a prudential "ought" [102, p. 19]." A society expresses and generates its values and norms through tradition, social and political processes, legislation, laws and law enforcement. Legal history describes variety of changing values and norms for societies in changing environments; there are traditions, learning, adaptations, tests and conflicts. Clearly, dimensions of political power have much to do with such processes. Can we find within such dynamic historic processes evidence for invariances that allow us to "anchor" human behavior as individuals and as groups to some basic "value" dimensions?

In the traditional economics and respective "value sciences" the individual value behavior was taken as the starting point, as one finds in the Walras-Pareto general equilibrium model. This notion of the individual value behavior was then carried also to the welfare economics and the respective roles for the public sector. Interpersonal utility comparisons were not allowed; they were not "scientific". Nowadays many economists are interested in the choice behavior of groups as distinct from that of individuals: they attempt to construct collective social welfare functions for the justification of the "effectiveness" of private and public economic activities. They argue among other things that individuals really interact in groups, and that at least certain minimum needs for subsistence are really measurable and interindividually comparable.

Whether one deals with individual or group preference functions, there is the important question: how dynamic or stable are these functions, how strongly do they interact with the influences of changing environments, other social groups, structure and direction of political power, and so on? How do they change from one situation to another one,

how do they change with location, geographic setting, and dynamics of social action? Can "value science" discover some basic invariances that allow us to predict human value behavior in a changing society, in a changing culture or civilization? Can we really hope to "anchor" our economic, social and political theories to such invariances if they can be found? As Ward noted, can economics deal with such "moving targets" of changing values: can, indeed, "value sciences" deal with such moving targets of changing individual, social, and cultural values? Ward notes how the law and the judicial process is much more empirically oriented to treat changing values of a society than the rigid, statically rigid prescriptive "value sciences" of economists [95].

The volume of utility and preference theory is large. In relation to this large volume of theoretical expositions the empirical work done for these theories by psychologists, sociologists, economists and political scientists is rather meager and inconclusive. Perhaps, the most serious empirical work on preferences and consumer behavior appears in market research. Here the problems are practically oriented, and the preconceived notions arising from utility theory seem to be kept down at "proper perspectives" in relation to needs to find effective marketing solutions for old and new products. The historic development of the utility and preference theory are given, among others, by Stigler [103] and Houthakker [104]. Among survey articles Fishburn [105], and Hull, Moore, and Thomas [106] are relatively recent ones.

According to Fishburn, "On the practical level, utility theory is concerned with people's choices and decisions. It is concerned also with people's preferences and with judgment of preferability, worth, value, goodness or any number of similar concepts. ... Interpretations of utility theory are often classified under two headings, prediction and prescription. The predictive approach is interested in the ability of a theory to predict actual choice behavior. The prescriptive approach is interested in saying how a person ought to make a decision [105, pp. 335, 336]." Prescriptive utility theory emphasizes the "rationality" of choice and decision making processes. Fishburn lists the following three main purposes of prescriptive utility theory:

1. Utility theory serves as a normative guide in assisting the decision maker codify his preferences.
2. Utility theory helps the decision maker discover, innovate, learn to recognize patterns to determine his preferences between complex alternative in situations of certainty and uncertainty.
3. A basic purpose of utility theory is to enable the decision maker's preferences to be transformed into a numerical utility structure to be used in conjunction with an optimization process. A typical problem is to maximize utility under a set of given constraints.

Fishburn notes [105, p. 341], that "...many experiments undertaken by psychologists ... have indicated that most of the theories tested are not notoriously good predictors of choice behavior. At the present time .. the predictive work in utility theory carried out by psychologists seem to offer little aid to the individual decision maker. most practical situations differ from experimental ones in being more complex and nonrepetitive."

Hull, Moore and Thomas evaluate the literature on the measurement of utility [106]. They make a distinction between unidimensional and multidimensional utility versus approach and methods for measurement. For unidimensional utility measurements they classify those methods that

- a. make minimal assumptions, and
- b. make assumptions about the functional form of the utility function, or about the properties it must have.

In the case of multidimensional utility functions more than one variable is used to describe outcomes. In a business situation these variables could be, for example, asset position, market share, and turnover, Hull, Moore and Thomas list the following types of multidimensional utility functions for individual decision makers:

1. A linear utility function.
2. An additive utility function.
3. A lexicographic utility function.
4. A utility function with some other specified properties.

Hull, Moore and Thomas address the question of group utility. In many cases groups of people, institutions, firms, policy councils, and so on, must choose between alternatives. "There is ... no reason to suppose a priori that there exists any voting or bargaining process which will result in a single group utility, i.e. there is no reason to suppose that a group, whatever the decision procedures it adopts will act "rationally" and maximize the expectation of a utility function.. [106, p. 240]." In group interactions individuals have more or less imperfect information, authority and political power has effects, learning takes place, and individual values shift.

The authors make the following comments in their conclusion of the paper: "Expected utility has two important advantages over expected monetary value as a decision criterion in business. Firstly, it can take into account the risk aversion of the decision-maker. Secondly, it enables decision situations with non-monetary outcomes to be evaluated.

... Non-monetary outcomes are encountered frequently in Cost Benefit Analysis studies. Here it is current practice to assume that each component in the outcome can be traded off at a constant rate with money. There are many situations where this is not in fact a reasonable assumption and it is, therefore, clear that there are advantages to be gained from introducing the ideas of modern utility theory in this area. the bias inherent in psychological experiments and the unreality of the decision situations portrayed in those experiments suggest that efforts should be made to apply utility analysis to on-line public and business decision situations [106, pp. 245-246]."

In a society political power rests often with social groups. They can collectively assert their values upon the rest of the society. They vote not only within but with other groups, they play games, compromise, learn new angles and values in the processes, juggle, bargain; and in such processes new values and norms are generated. Churchman defines a social group as "any manifold of persons, identifiable over a period of time, and sufficiently integrated so that its actions and objectives are identifiable [102, Chapter 12]." By this definition, a social group is neither a static nor a permanent entity. Its characteristics can change from one situation to a next one, and it can have internal and external dynamics. The concept of group values can have several meanings. Churchman lists in particular the following ones:

1. A group can be considered as a "collective", independent of the properties of its members.
2. A group may be considered in terms of its members, and one could attempt to define group properties as a function of member properties.
3. A group could be defined both in terms of the member properties and the group properties.

Now these three ways of defining and studying a group could be subjected to the following assertions:

- a. The properties of members are sufficient to define the properties of the group, i.e. any property of the group (e.g. values, believes, norms) can be defined as a function of the properties of one or more of its members.
- b. The properties of the members are necessary to define the properties of the group, e.g. the function that defines the group property must include member properties.

Definition 1 above denies explicitly b while making no comments on a. Definition 2 above affirms both a and b, i.e. member properties are necessary and sufficient for the definition of the function that characterizes the group. Definition 3 affirms b but denies a, i.e. member properties are necessary but not sufficient for the characterization of a social group. Clearly, the way a group is defined has

important consequences on how social group values are to be understood and treated. All these definitions are discussed by Churchman [102, Chapter 12], and in an interactive interdependent society it might well be that the definition 3 might make the most sense: the properties of social groups are not only defined in terms of the properties of its members but also by some additional properties. This "conceptual scheme ... is in a sense 'organic'. The group is made up of elements with differing characteristics, and out of these differences arises a coherent type of group behavior that is not identified with the properties of any one of its members [102, p. 309]."

Groups, human institutions, can be seen to have dynamic life cycles: they are born, grow, mature, saturate and decline toward an eventual death. Group dynamics deals not only with the dynamics of interactions between the member of a group, but also with the dynamics of the interactions of a group with other groups and with the overall societal environment. In relation to the "value sciences" of the traditional microeconomic theory, there is a considerable interest to understand group values, for example, in terms of the definition 3 discussed previously. Arrow's Social Choice and Individual Values is a classical example of this [51].

8. FROM POLICY TO PROSPECTIVE SCIENCES

The business of policy sciences is to search for "possible futures" and to identify, synthesize possible goal patterns for these "futures". It is a business of a goal oriented anticipation, prediction and forecasting. As the broad goal patterns emerge out in this process of anticipation the next task is to select a most promising goal pattern consistent with the values and norms given to a policy designer. The process is synthetic in nature. As the process moves to the strategic planning level, the level of specificity is increased. Figure 15 illustrates the yet synthetic process at this level and its iterative "planning cycle" process [71, pp. 30-34]. In a way, the value-policy-strategy-tactical iterative cycle is an attempt at an "optimal pursuit" of a "moving target", a goal pattern moving and changing its shape in a foreseeable future and to be reached in some manner approaching a "least effort" to do the job.

At the strategic planning level the "decision environment" is to be identified in a more specific manner than at the policy planning level: A decision environment with its "states of affairs" or "states of nature" are to be patterned out; the realizable, feasible alternative actions need to be identified; and then the pay-offs or penalties or utilities associated with each and all the actions for each and all the "states of affairs" need to be specified. As all this is done for the future, the whole setting of such structuring is in terms of a forecast. The knowledge of doing all this may not be perfect, and we therefore must live with some element of ignorance as to the precise

nature of the states of nature, actions, and pay-offs or penalties. Added to this problem of ignorance or lack of knowledge there is also the problem of uncertainty in that we may be able to predict the future states of circumstances only in terms of their probabilities of occurrence. The way to choose such probabilities depends on our knowledge of past events and current indicators "favoring" or "disfavoring" occurrence of certain events in the future.

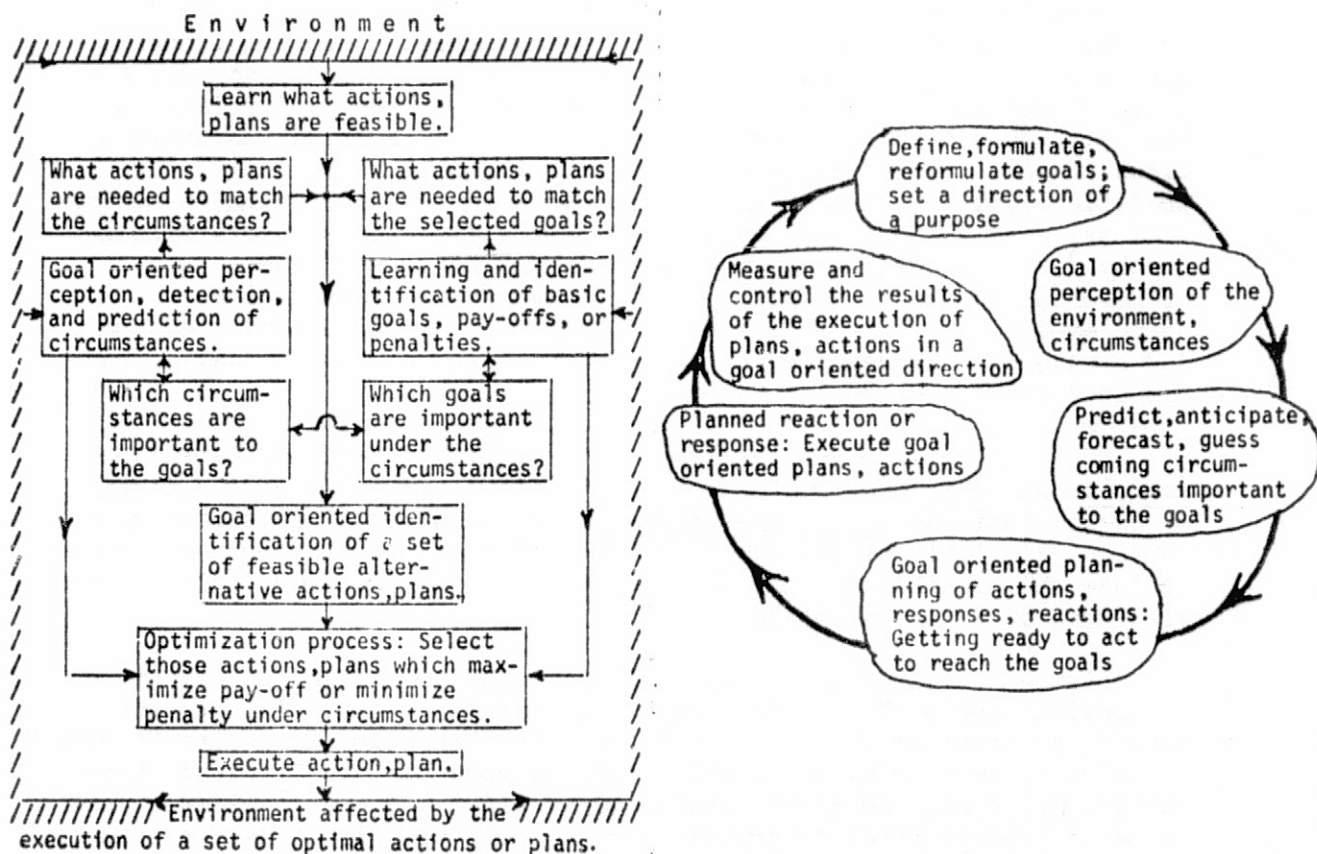


Figure 15. Simplified illustration of a decision process and its iterative cycling.

The whole purpose of setting up and developing such a decision problem in a logical framework is the determination of an "optimal decision", a decision which under uncertainty would give us a solution with an "expected least effort" to reach it.

The literature on decision theory is considerable, and the references [107,108,109,110] are some more prominent example among many. If the "nature" or "circumstances" facing the decision maker have conflicting or completing or cooperative aspects including other "players", then decision theory becomes also game theory [111,112,113]. The notion of gaming as an aspect of an "optimizing behavior" can be detected already in the works of Cournot and von Stackelberg [1, pp. 222-253].

It is important to note here that decision and game theory can be extended to treat the cases of an optimal pursuit of "moving targets". Further, such processes could include adaptive learning processes. While the Cournot-von Stackelberg-von Neumann decision-gaming approach to microeconomics suggests a useful approach to politically powerful economic agents from the microeconomics side, the aggregated economics suggests a useful approach to treat collective behavior. The institutional and historic schools of economics add basic long-run political interpretations to this mixed "structural" approach to political economy. The traditional macroeconomics as a policy science and as a decision making tool has been evidently too mechanistic like the Walras-Pareto fixation of the past. It has not recognized the "moving target" gaming aspect of powerful economic, social, political agents and institutions and historic evolution of the societies in a world of ever increasing economic and strategic interdependences but characterized by a politically fractionated overstructure.

Decision sciences suffer from overmechanization in the direction of decision analysis as a mechanical and atomistic exercise at the expense of the emphasis on decision synthesis. It is interesting to observe the apparent hostility of the so-called "decision scientists" if one suggests to them the possibility that decision analysis is, perhaps, only a minor aftermath of decision synthesis.

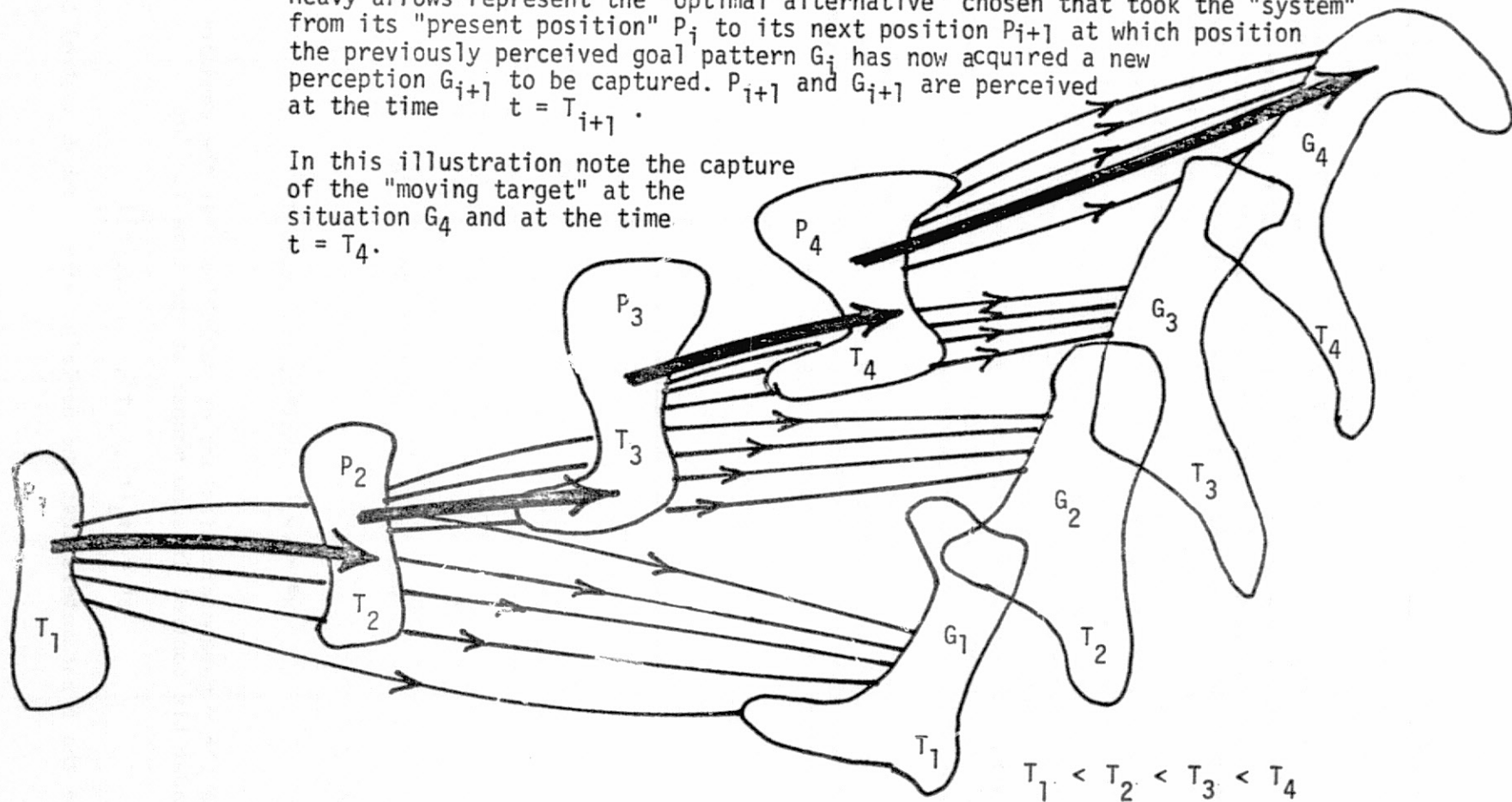
Figure 16 illustrates a planning-decision process as an attempt at an "optimal pursuit" of a "moving target" goal pattern. The process is assumed to start at the time $t = T_1$ when the "pursuer" is at its "present" position P_1 perceiving a "possible future" goal pattern G_1 by his best forecasts. Among the five possible alternative actions considered feasible at this position he evaluates the second one (from the top) as the "optimal strategy". He develops the respective operational plan and executes it to arrive at a new position P_2 at the time $t = T_2$. Meanwhile situation has changed, and now the pursuer perceives a new goal pattern G_2 . Among the four feasible routes to reach this new forecasted "possible future" the pursuer finds the third action (from the top) "optimal", i.e. the action of "least effort". He implements the respective operational plans, executes them, and arrives thereafter at the position P_3 perceiving now after some more learning a shifted goal pattern G_3 ; this all happens at the time $t = T_3$. The pursuer now finds four feasible alternative routes to reach G_3 , and finds among them the first one from the top "optimal", i.e. the route of least effort. He now

Figure 16. A sequential "optimal pursuit" illustration of a planning-decision process with learning and adaptive characteristics.

Light arrows represent possible alternatives from the "present position" P_i at the time $t = T_i$ to the respective perceived goal pattern G_i at that time.

Heavy arrows represent the "optimal alternative" chosen that took the "system" from its "present position" P_i to its next position P_{i+1} at which position the previously perceived goal pattern G_i has now acquired a new perception G_{i+1} to be captured. P_{i+1} and G_{i+1} are perceived at the time $t = T_{i+1}$.

In this illustration note the capture of the "moving target" at the situation G_4 and at the time $t = T_4$.



develops and executes the respective operation that takes him to the position P_4 at the time $t = T_4$. Here he re-evaluates the situation visualizing a new shifted goal pattern G_4 and five feasible alternative routes to reach it. He finds the fourth one from the top "optimal" and plans and executes it. He reaches or "captures" the "moving target goal" at the time $t = T_4$ in this "happy" illustration. And, again, he might not be able to capture his moving target goal pattern. Note how in this illustration the shape and position of the goal pattern shifts over time. At each position P_i the pursuer "re-evaluates" his position and with respect to his new perception of the goal pattern. He then commits himself to the next supposedly "optimal" move in an attempt to capture the perceived goal pattern in its anticipated new position and shape. This kind of a capturing process involves adaptive and learning processes by the pursuer, and it can involve a gaming situation not only between the pursuer and his target but between him and the target and other pursuers. It is here where the "conventional decision sciences" may fall far too short from being realistic for practical decision making purposes. However, such theory and science might be useful for each particular stage of the re-evaluation by the pursuer when he seeks for the next "optimal" move while chasing the "moving target" goal pattern.

At any position $P(t)$ at the time t the decision maker visions a future goal pattern $G(t, \theta)$ with a forecasted capture time θ from the present time t into the future time $t + \theta$. In a discrete case he might formulate his decision problem as follows:

P_1	P_2	.....	P_j	.....	P_m		
S_1	S_2	.....	S_j	.....	S_m		
<hr/>						<hr/>	
U_{11}	U_{21}	.....	U_{1j}	.....	U_{1m}	A_1	q_1
U_{21}	U_{22}	.....	U_{2j}	.....	U_{2m}	A_2	q_2
\vdots	\vdots		\vdots		\vdots	\vdots	\vdots
U_{i1}	U_{i2}	.....	U_{ij}	.....	U_{im}	A_i	q_i
\vdots	\vdots		\vdots		\vdots	\vdots	\vdots
U_{n1}	U_{n2}	.....	U_{nj}	.....	U_{nm}	A_n	q_n

Let

$$x^* = (x_1(t), x_2(t), \dots, x_r(t))$$

be the r parameters, factors or variables that the decision maker has under his control in some manner at the time t . Let

$$z^* = (z_1(t), z_2(t), \dots, z_s(t))$$

be the s parameters that the decision maker cannot control but which are

considered necessary for the characterization of the noncontrollable decision environment. Then x^* and z^* are identified and singled out as the "modeling" variables, parameters or factors of the decision problem tentatively considered as necessary and sufficient for the description of the decision situation over the prescribed time horizon θ . However, x^* and z^* are functions of time t . Then, also, the functions of time

$$\begin{aligned} S_j &= S_j[x^*(t), z^*(t), \theta] \\ A_i &= A_i[x^*(t), z^*(t), \theta] \\ p_j &= p_j[x^*(t), z^*(t), \theta] \\ q_i &= q_i[x^*(t), z^*(t), \theta] \\ U_{ij} &= U_{ij}[x^*(t), z^*(t), \theta] \\ i &= 1, 2, 3, \dots, n \\ j &= 1, 2, 3, \dots, m \end{aligned}$$

are supposed to be characterized by the planner-decision maker. Here S_j are the "states of circumstances". The set $[S_j]$ is assumed to be a partition of a "sample space", supposedly complete for the characterization of the "decision environment" facing the decision maker. Then p_j are the probabilities assigned to the simple events S_j over this sample space or "universal set". A_i are the feasible actions identified by the planner-decision maker. The sample space of actions has the partition $[A_i]$ of "simple events" A_i . q_i are the probabilities assigned to these simple events A_i , respectively. The necessary requirements for an acceptable probability assignments are:

$$p_j > 0 ; \sum_j p_j = 1 \quad \text{and} \quad q_i > 0 ; \sum_i q_i = 1 ; \quad j = 1, 2, \dots, m;$$

$$i = 1, 2, \dots, n$$

U_{ij} are called the utility values associated with the state of circumstances S_j and the planner-decision maker's action A_i . The expected utility for action A_i over all the states of circumstances S_j is then

$$E(U_i) = \sum_j U_{ij} p_j$$

and the expected utility for a state of affairs S_j over all actions A_i is, respectively,

$$E(U_j) = \sum_i U_{ij} q_i$$

The overall expected utility over all actions A_i and states S_j is

$$E(U) = \sum_i \sum_j U_{ij} q_i p_j$$

Now, if the formulation of the decision problem is not correct or complete - for example, if actions are incorrectly specified or if the states of circumstances are not properly identified - then we talk about a problem of ignorance. That is, if the planner-decision maker has not been able to formulate an appropriate relevant decision model simply because he is unable to know what is going to happen over the time horizon θ in a reasonably complete and correct manner, then we say that he is plagued with a problem of ignorance. Apart from the problem of ignorance there is also a problem of uncertainty. Suppose that S_j , A_i , p_j , q_i and U_{ij} are, indeed, identified and constructed in a relevant and reasonably complete manner. Then uncertainty is a formal property of the probability assignments p_j and q_i to S_j and A_i , respectively. Then in a general way uncertainty measures a dispersion of the probable occurrence of events, or uniformity or "disorder" of their probability assignments. Regardless whether a probability assignment is mono- or multi-modal in nature, the entropy of the probability assignment will always work out as good measure of dispersion or uncertainty. Thus

$$H_j = - \sum_j p_j \log p_j$$

is the uncertainty associated with the states of circumstances S_j ;

$$H_i = - \sum_i q_i \log q_i$$

is the uncertainty associated with the actions A_i , and in the case where events S_j and A_i are mutually independent, $i=1,2,\dots,n$; $j=1,2,\dots,m$;

$$H = - \sum_i \sum_j q_i p_j \log q_i p_j$$

is the uncertainty associated with the overall expected utility of the decision problem. It should be noted that the formulation here is readily converted to a two-person zero-sum game if the "circumstances" minmax with the decision maker and when the loss of one of the two players is the gain of the other one. Few notes should be made about such games with zero-sum and two players: they are unrealistic; they assume that each player knows all the alternatives of the other player and that both players have an identical measure for gains and losses. The problem with most realistic decision and gaming problems is among other things the problems of ignorance preventing a complete specification and accountability of the decision or gaming situation. The problem of ignorance could conceivably swamp the problem arising from an apparent uncertainty associated with an incomplete or irrelevant decision or gaming problem. For example, if x^* , z^* and/or θ are not completely identified and/or are not properly portraying the decision or gaming situation, then a pure analytic manipulation and decision analysis cannot help the planner-decision maker. Typically, one must expect perhaps even serious empirical problems to be associated with the formulation of a proper and relevant decision "model".

The decision maker wants to maximize his expected utility. But if the model or map to do this job is not correct, he would end up with nonsensical results. The relevancy and completeness of a decision-gaming scheme or model is a fundamentally important aspect of strategic planning. It should be noted that formal methods, per se, can improve the way a planner-decision maker looks at and understands a decision situation. Further, such formal and analytical schemes can improve the accountability of a decision process. However, if the decision model or "map" incorrectly portrays its supposedly corresponding "landscape", then it is not only useless but actually misleading in the attempts of a decision maker trying to navigate through the dangerous waters filled with wrong decisions.

A decision model or "map" is a part of a decision information system which is supposed to provide to the decision maker a good basis for synthesis and analysis in order to minimize costly wrong decisions. But information also is costly. A decision information system must by itself be "cost-effective". Figure 17 illustrates this property of a decision information system. $C_W(I)$ is the expected cost of making wrong decisions as a function of the amount I of information provided by the decision information system. $C_I(I)$ is the cost of information system itself as a function of the amount of information, I . Then the total cost of making decisions is $C_T(I) = C_W(I) + C_I(I)$. For $C_I(I)$ some economies of scale are assumed in this illustration. The total cost has a minimum $C_{T \min}$ at an optimal amount of information I_{opt} . This minimum cost-optimum information point represents the "best" cost-effectiveness situation for the decision process. For example, a benefit-cost analysis of a program should also include the "benefit-cost" analysis of its own information system and information processing.

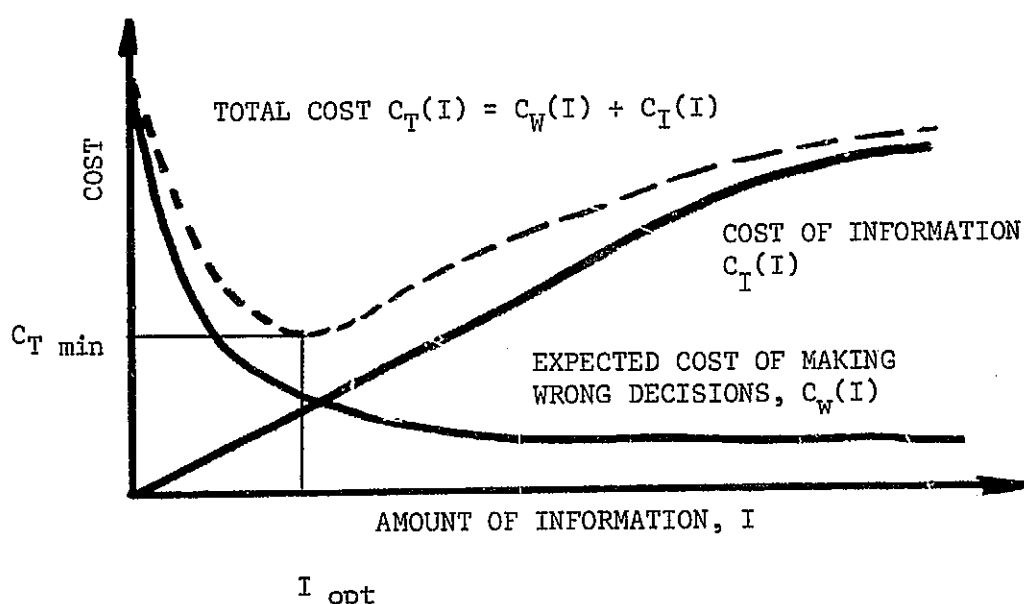


Figure 17. An illustration of an "optimal" decision information system.

Planning-decision processes require necessary prediction and forecasting of "possible futures" in a setting of appropriate feasibility considerations. In some cases a program can force out its own anticipated solution. Given enough power of execution, a program could carry with itself its own self-fulfilling prophesy. In most cases this may not be the case. The one must develop a successful enough predictive model for the estimation of future economic, social and political impacts of a project or program, policy or strategy. Few comments should be made here about such predictive models or maps. A model is a caricature or portrayal of its supposed "landscape" or actual process such as social action or economic behavior. Typically, a model is characterized by a set of parameters, relationships and variables with the hopes that there are some basic invariances that hold from the past through the present into the future. If the society behaves over some period of time in the future as it has done over another period of time in the recent past and as it seems to be doing now, then the planner-decision-maker extrapolates the past and present into the future behavior within the framework of his model. Such a "simple trend" forecasting may have to be modified as current events indicate that some invariances previously assumed are really not invariances. Such observations can inspire corrections in the parameters of the model as a matter of after the fact adaptive corrections in the model. In such a case the model adaptively chases its supposed reality with some lag in a dynamic setting. Its supposed reality is a "moving target" with which the model attempts to intersect in a sense of a reasonable correspondence. Then this interception intersection can be conceived as a measure of success for the model necessary also for a successful forecasting function. Many of the so-called trend forecasting models and econometric models are of this sort. They use prior and contemporary information to establish a posteriori information for future forecasts. For example, Bayesian decision theory is an attempt in this direction.

While in the above cases models were modified by adjusting their supposed invariances after the fact, the next hierarchy in attempts to improve forecasting functions would be the prediction or anticipation of the future shifts in the supposed invariances of the model. While after the fact adaptive corrections are corrective feedback processes, the predictive or anticipatory adaptive corrections are more like feed-forward type, "getting ready before the fact". In such situations a model is made to "anticipate ahead of time" where it would intercept with a large intersection its supposed reality. In this case the "optimal pursuit" is anticipatory, corrections and adaptations foreseen ahead of time, before the fact. In this case it is even conceivable that the model leads over the time its supposed dynamic reality. Figure 18 illustrates the after-the-fact and before-the-fact pursuit processes of an adaptive modeling chasing its supposed reality. The solid trajectories belong to the "realities" and the dashed trajectories to those of their respective models. Figuratively, also the shapes of the "realities" and their respective models would change over time. The overlaps between the "realities" and their respective models illustrate figuratively the degree of correspondence between the two. Of course,

in most realistic situations the "signals" are not clean for the testing of the models. Data and information will be "noisy". The problems would be complicated with the additional effects of the expected non-stationary characteristics of this "noise" in social sciences.

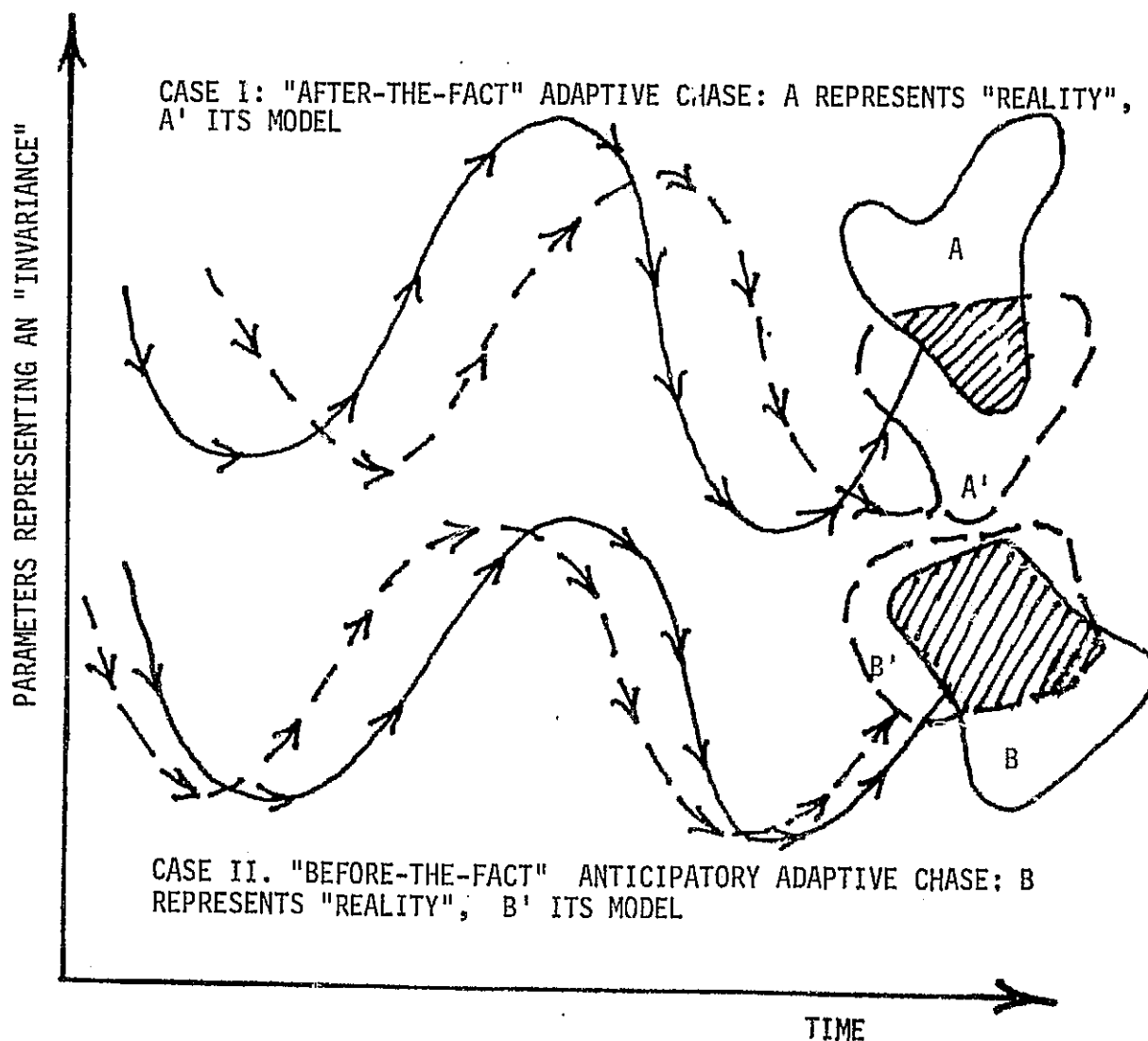


Figure 18. A lagging chase (Case I) and a leading chase (Case II) illustrating adaptive modeling. The overlap between a "reality" (A or B) and its respective model (A' or B') represents a predictive correspondence.

9. FROM PROSPECTIVE TO ADMINISTRATIVE AND MANAGEMENT SCIENCES

The policy planning function was basically broad in scope and synthetic in nature. The approach to the identification and specification of the plans becomes increasingly analytic and specific as the process shifts from the policy planning level through the strategic planning level to the "nuts and bolts" level of operational planning, implementation, execution and control. Correspondingly, the methodologies of the supporting sciences becomes also more specific, more detailed and, also, more analytic in their nature. At the operational levels operations analysis and research, management and administrative sciences, systems engineering methods, managerial and engineering economics, specific cost-effectiveness and benefit-cost methodologies, and a variety of statistical and simulation techniques become more amenable for practical problem solving situations. A variety of specific planning techniques such as PERT and other modified network techniques become possible as the specificity of the program structure emerges out in an increasing detail. References [116,117,118,119,120,121] provide a sample of a historic evolution of operations research.

Over last decade it has become increasingly evident that the practitioners of operations research and management sciences may have been overtly methods happy, thereby tending to become one track minded and atomistic in attempts to generate solutions to "holistic" problems. A part of this tendency lies in an emphasis on sophisticated algorithms at the expense of reduced human communications and a certain neglect of human element in an operational environment. Many operations research efforts were actually poorly conceived and executed with terrible records of "cost-effectiveness" and with disappointing end results. On the top of this, OR practices were plagued with some quackery typical to "novelty" cures proposed to ailing business operations. Some OR practitioners neglected the golden rule of "effective simplicity" and proposed complicated approaches to relatively simple problems understandably with chaotic and expensive solutions and recommendations to the disappointment of practical businessmen. Other OR men became so enamored with their pet methods of solving problems that they painstakingly forced all kinds of problems into a form that somehow could be fitted to their chosen method of solution. The pains and aches due to "novelty happiness" appeared in such areas as automatic process control, management information systems, and production scheduling involving a high human element. In some cases management did not have a correct perception of the OR activity, and expected instant miracles for their ailing operations. As a result of these kinds of experiences and the concomitant learning processes, OR and systems approach has gradually become more realistic and with an increasing emphasis on effective problem identification and definition before any premature problem solving attempts. Especially in the areas with a human content OR ceases to be just a science but becomes an innovative art. Further, the OR practitioners should have learned for their own operations what they were preaching to others: there is a diminishing marginal utility of the added complexity in trying to solve practical problems.

It appears that OR and management sciences are still at a relatively atomistic stage. Although they may work satisfactorily at an operational level, their contributions upward toward a policy planning level may still be relatively restricted by their inbuilt "bounded rationality".

Although managerial and engineering economics will be discussed in the subsequent section, few words seem appropriate here: basically managerial and engineering economics is a branch of capital investment theory and practice, readily translated also to applications in cost-effectiveness and benefit-cost analysis. The general idea is to justify an investment in a new venture or capital equipment as an alternative against other alternative uses of resources. Such an analysis can include also risk analysis, effects of maintenance and replacement policies, technological obsolescence, and possible synergistic effects due to other investment choices.

10. CONCLUDING REMARKS

Especially since the Second World War the so-called Neo-Keynesian macroeconomic theory has been one of the main "policy sciences". On the other hand, the traditional microeconomic theory has been a main "operational science" for benefit-cost analysis. Of course, attempts have been made to bridge these two ends of a planning-decision process so that program-effectiveness could be somehow related to the criteria dictated by a public policy. In this setting, however, the troubles associated with the economic foundations of benefit-cost analysis are found both at the policy and at the operational levels.

The Neo-Keynesian macroeconomic theory did live through a period of success as a policy science but has recently failed to carry out a continuation of this positive image. It may be argued that this economic theory has been a bit too "mechanistic", far too aggregated, too short-run oriented, and too much purely exchange market and consumption oriented in order to identify and isolate powerful economic, social and political individuals, agents and institutions having appreciable control over local and global economic resources, their uses, pricing, wage determination, a variety of financial and debt manipulations, and so on, which singly or in a combination have affected, impacted or dislocated the assumed patterns of economic behavior. The Neo-Keynesian "policy science" has not fully appreciated the institutional and political dimensions nor the "historic evolution" characterized by political, demographic, technological and cultural shifts, not only of a national but also of a global nature. It has been too insensitive to the nature of "gaming" going on between a variety of interest groups such as major corporations and labor groups or those between multinational corporations and nation-states. Its emphasis on exchange market and consumption economy has made it partially blind and rather incomplete to handle long run problems of economic - and hence - social and political developments. As a "value science", the Neo-Keynesian theory has singled out consumption (of whatever) as the glorious end value of human life, and per

capita consumption has become the measure of "haves" versus "have nots" supposedly characterizing the strength and well being or weaknesses of human beings in an almost universal way.

At the level of program evaluation, the benefit-cost analysis has been based greatly on the "operational science" of Walras-Pareto micro-economics and its extensions to include a variety of "imperfections" of the ideal norm of "perfect competition". While the Walras-Pareto model served the purpose of a normative "value science" on its own account, its behavioral assumptions were at best far from a reality. It, too, had grown into a rather "mechanistic science" ignoring institutional, social and political dimensions which, in contrast, were so strongly pointed out, for example, by the American School of Institutional Economics. However, institutionalists faded away under the steamroller of the fashionable neoclassical formalistic schools of economics. With it, benefit-cost analysis became an exercise in a sterile but popular micro-economics with no assurances that this exercise had any relevance with respect to economic, social and political reality.

The serious question now is how to develop a "benefit-cost" evaluation that somehow relates to a policy reality on one hand and to an operational reality on the other hand. It may well be that a "purely economic" dimension will not suffice nor be necessarily a unique reflection of the society's values, needs, desires, and actions. If so, then it might be desirable to investigate what kinds of factors must be added to "purely economic" ones in order to arrive at some meaningful and relevant total assessment profile for the evaluation of public programs.

IV. MANAGERIAL AND ENGINEERING ECONOMICS

1. INTRODUCTION

At the strategic and operational levels of planning-decision processes the so-called managerial and engineering economics plays traditionally an important role. Historically its origins can be traced into antiquity. It seems that the survival and growth of human societies were made possible by social and technological innovations and the cumulative experience thereof. As the human knowledge cumulated forming an ever growing foundation for new innovations, the societies transformed from gathering and hunting societies to nomadic pastoral societies, then to agricultural and trading societies, and finally to the contemporary commercial, urban and industrial societies. In this sequence of transformations the relative role of managerial and technological activities have increased for the purpose of utilizing scarce resources effectively in an increasingly complex and interdependent economic, social and political environment.

For example, the role of technology and engineering in the establishment of effective irrigation systems was obviously important in the evolution of the urban centers in Sumer, Indus, Egypt and Hwang-Ho thousands of years ago. Concomitant with such urban evolution one finds the gradual evolution of sophisticated management systems: inventory control, accounting systems, principles and methods of taxation, and allocation of productive resources [122,123,124,125]. A good manager is exemplified by Joseph in Egypt who utilized good long-run planning, production, allocation and inventory control to smooth out the potentially detrimental effects of a "business cycle" generated by the seven fat and seven lean years. The records now discovered from the city states of Sumer indicate a surprisingly high level of managerial and technological planning principles and methods, accounting practices, contractual arrangements, and so on, in order to manage relatively extensive urban-rural complexes. Many of the contemporary contractual, financial and accounting practices evolved over long periods of time, for example, through practices of such "multinational" or "international" trading ventures as those of Phoenicians, the Silk Road traders, the Hansa League, and the emerging lending, financing and banking business in the Medieval Europe, Islamic World and Bysantium.

Around 1750 the Industrial Revolution emerged with four basic technological developments: the replacement of tools by machines, the introduction of new prime movers, the development of mobile prime movers, and emergence of the factory as a new form of production organization. The impact of science and engineering became very pronounced, and transformed onto the foregrounds of economic considerations. At the same time the Industrial Revolution promoted through specialization growth in trade and commercialism, and in financial and banking institutions. Massive international commodity and raw materials markets emerged. Managerial and engineering economics evolved out as an important prospective and operational "science" whose purpose was to help planners and decision makers to do a better job in this environment of increasing interdependences and complexities. It was in such an environment where managerial and engineering economics blossomed out and evolved into its present prominent status.

2. A SKETCH OF THE RECENT HISTORIC EVOLUTION OF MANAGERIAL AND ENGINEERING ECONOMICS

In a specialized and interdependent exchange economy goods and services are purchased for some specified value in a market place. This specified value could be used to purchase various alternative goods and services. Which of these alternatives would be most beneficial? If a lender provides this specified value at a cost of some interest rate, what then would be the best alternative to cover the interest cost plus to provide maximum benefits over and above this interest cost? Traditionally the managerial and engineering economics expanded out from these kinds of considerations to a multitude of additional factors and levels of complexity. As a prospective and operational "science" the

managerial and engineering economics helps the decision maker in selecting among technologically feasible alternatives the "best possible" alternatives in a setting of scarce resources. Typically, what is the "best possible" alternative relates to economic benefits minus economic costs at the operational level. At a strategic or policy level other criteria than purely economic ones are often introduced, and, therefore, managerial and engineering economics might not suffice for the final selection of a "best alternative". The classical engineering economics is really a branch of classical capital investment theory in a private sector. For the area of resource development in the public sector it becomes benefit-cost analysis typically augmented with economic analysis relating to such effects as "externalities" between the private and public sectors or welfare economics [1, 126].

From an accounting point of view, the managerial and engineering economics focuses on "relevant" costs and "relevant" revenues associated with a venture or investment, i.e. costs and revenues that are under the decision maker's control. Such costs and revenues relate to "opportunity" costs and "opportunity" revenues, respectively. As costs and revenues are really streams or flows over time, and as future and/or past may be discounted, the venture analysis rests traditionally heavily on analysis of discounted cash flows.

The early managerial and engineering economics as a venture analysis of discounted value flows was limited by the mathematical and computational techniques for calculating interest rates. A. D. Stevin's "Tables of Interest" (1558) appears to be the first one to record also interest formulas. Other reasons for the slow emergence of published interest tables and formulas were the secrecy of the lending institutions in order to guard their practices, and the general ethical tone of the Medieval European society that identified banking and lending business with usury [127].

Wellington's book "The Economic Theory of the Location of Railways" in 1887 appears to be the first classic in engineering economics. He used capitalized costs for choosing the best alternative from a set of alternative lengths of rail lines and a set of alternative curvatures of the railroads. He also promoted planning and forecasting by pointing out that railroad facilities should be constructed for anticipated future traffic volumes rather than the current ones. He predicted the future traffic volume on a basis of a compound interest growth. However, he was careful to point out that such projections should be made for a three year period but not for a period exceeding ten years. He stipulated the upper limit as he had noted the sensitivity of railroad traffic to business cycles [126,128].

The impact of the evolution of classical microeconomic theory on the managerial and engineering economics is strong. The classical price and value theory provided a rationale for revenue and cost imputations and accounting related to market forces. On the technology side the traditional "Roman Engineering" had split into military and civil

engineering. The latter one became increasingly involved in a commercially oriented perspective of the private and public sectors of the evolving industrial society. While during the Roman era such projects as the Appian Way on the "national scale" or aqueducts on a "municipal scale" illustrated the importance of technology for the society, during the growth of the industrial society irrigation and canal systems, road networks, railroads, communication networks, shipping harbors, and so on, gain specialized importance not only from the point of view of a variety of private enterprises but from the point of view of a public policy. The intensifying specialization and concomitant interdependence of the industrialization made such transportation and communication technologies necessary supporting systems for a "national survival". During this era of early industrialization, civil engineering became increasingly involved with evaluations of alternative choices of developing such necessary supporting systems, and such evaluations acquired definite pecuniary, financial, and commercial dimensions.

Right after the turn of the century through the First World War the financial dimension emerged to the foreground in managerial and engineering economics. Investment models utilizing financial and actuarial mathematics appeared. Technology was viewed with an increasing economic emphasis. The technological venture analysis merged with capitalistic venture analysis. The concept of econo-technological optimization became formalized. An engineer was to become also an economist: this became his "duty" in the name of efficiency for private and public institutions.

Factory as a productive institution is a combination of technological and capitalistic concepts. It is a venture that must justify its existence by the use value of its production outputs and by the technological and managerial cost-effectiveness of its operations in converting inputs into outputs. It is an investment in and a commitment to use of scarce resources that could be used otherwise. Therefore, it is not surprising that managerial and engineering economics became a branch of capital and investment theory and practice. After the World War II managerial and engineering economics increasingly overlapped with concepts of capital markets (supply and demand), capital budgeting, investment replacement, portfolio analysis, and the principles and concepts of accounting and financial management.

As the scope of the managerial and engineering economics increased during and after the Second World War, income tax considerations, after tax analysis, effects of risk and uncertainty, project planning and scheduling concepts, optimization using mathematical programming, operations research and simulation, new techniques of dynamic modeling (e.g. Industrial Dynamics), decision sciences, and a variety of novel systems concepts were added to its confines among other things [129].

The methodological and quantitative dimensions of managerial and engineering economics provided a natural foundation to cost-effectiveness studies with their emphasis on optimization and to benefit-cost analysis for the selection of best "investments" or projects in the

public sector of economic activity. While the market mechanisms of the private sector were considered with an utmost importance, such analysis had to be augmented by the considerations of welfare economics with a special emphasis on beneficial "externalities" generated by the public sector upon the private sector of economic activity [1].

3. ECONOMIC ENVIRONMENT FOR MANAGERIAL AND ENGINEERING ECONOMICS

The traditional environment for managerial and engineering economics is that of microeconomics and capital theory; its basic planning-decision emphasis is on strategic and operational levels of a business enterprise. While the forecasts of various future expected revenue and cost streams may be based on a great variety of technological, economic, social and political factors, the identification of feasible alternatives and the selection of a "best alternative" is basically in a microeconomic setting.

To assess the economic desirability of the outcome of a decision-making process, the immediate and long range benefits and costs (expressed usually in monetary terms) must be determined. Since this is a pre-decision analysis rather than a post-decision analysis, much of the assessments of benefits and costs will rely on estimates, forecasts, or predictions that will by their nature introduce uncertainty and, possibly, a level of ignorance about the future. It is also understood that, since this is a pre-decision analysis to assist the decision-maker, economic evaluation statements must be performed on all alternatives under consideration including the no action alternative.

Subsequently, whenever the terms benefits and costs are used, reference is made to net benefits and net costs. In determining net benefits, consideration must be given to all direct and indirect benefits and dis-benefits that can be expressed in dollar amounts. In determining net costs, consideration must be given to all direct costs and incomes as well as external costs and incomes that might not be reflected in the market place or pricing system. The costs must be defined so that the benefits forgone or opportunity cost associated with the implemented project are considered. Double accounting of benefits and costs must be avoided. The following guidelines may be applied to all economic evaluation studies:

1. Determine the accounting scope associated with the project under consideration: does the economic evaluation of the project concern an individual, local, state, national or international government or private organization.
2. Determine to whom and how the benefits, dis-benefits, incomes and costs are distributed over the expected life of the project.
3. Determine the cost of capital or a discount rate that is applicable to the accounting stance.

4. Analyze the benefit and cost streams on a dimensionally equivalent value basis.
5. Determine the net benefit and net cost amounts from these dimensionally equivalent benefit and cost value streams.

The outputs of these determinations will be some numbers of net benefits and net costs measured in the same value units, and are then comparable.

The principles and techniques to be used in guidelines 3, 4, and 5 are contained in a body of knowledge known as Managerial and Engineering Economics. An elaboration of these principles and techniques will be given subsequently. A discussion of the principles and techniques associated with the guidelines 1 and 2 will be discussed under sections dealing with the state-of-the-art in Benefit-Cost Analysis.

4. MANAGERIAL AND ENGINEERING ECONOMICS - AN OVERVIEW

Time Value of Money

Guideline 2 requires that the total benefit-cost streams must be determined over the entire life of all the alternatives under consideration. Guideline 4 requires that these value or cash flows must be given in some value units in order to be compared on an equivalent basis. Thus it is necessary to convert these benefits and costs, which occur at different points in time over the life of the project, into a form that is dimensionally compatible and comparable. To achieve this, the principle of discounted cash or value flows is used.

Associated with the principle of discounted cash or value flow is the concept of "time value of money" and interest rate. As an example, consider a situation in which a loan of \$1,000 is secured to be used over the next three years at an interest rate of 8% compounded annually. There are a number of different payback schedules that could be considered, however let us choose a single payment at the end of the third year. A schedule of what is owed at the end of each year is as follows:

	Principle	Interest Year	Accum.	Total
End of Year 1	\$ 1,000.00	\$ 80.00	\$ 80.00	\$ 1,080.00
End of Year 2	1,000.00	86.40	166.40	1,166.40
End of Year 3	1,000.00	93.31	259.71	1,259.71

Thus the sum of \$1,259.71 has to be repayed at the end of the third year. That is, it costs \$259.71 to use the \$1,000 for three years. The time value of the \$1,000 today is worth \$1,259.71 three years from now at the specified annual interest rate of 8%. Conversely, the time value of \$1,259.71 three years from now is \$1,000 today at this 8% annual interest

rate. Equivalently, the present worth of \$1,259.71 three years hence is \$1,000 if the cost of capital is 8% annually. The technique of determining the present worth of a future sum is known as discounting, and is the reciprocal of the compounding process.

The terms "interest rate" and "cost of capital" are used interchangeably. However, interest usually means the payment for the use of debt capital rather than the profit from a business venture. Rate of return may be defined as the interest rate at which receipts are exactly equal to disbursements.

Interest

The concept of interest was used at least as early as during the Sumerian civilization, and has been conventional in financial transactions over thousands of years.

In early practices of barter trading the medium and unit of exchange was probably some prominent commodity itself. For example, if 10 bushels of wheat were loaned for seed at the end of one season, 20 bushels would be paid to the lender at the end of the next season. Therefore, perhaps through convenience, the natural annual agricultural cycle developed into an interest period. This annual interest period still prevails today. However many business transactions are conducted using interest periods of less than one year, or using even continuous compounding.

There are two types of interest.

1. Simple interest. Simple interest refers to the situation in which the interest is paid at the end of each interest period so that only the principle sum is carried across interest periods.
2. Compound interest. Compound interest refers to the situation in which the principle and interest are carried across interest periods so that interest is accumulated on interest. In this case the interest period is called the compounding period.

Since most financial transactions are for more than one interest period, compound interest formulas and interest tables have been developed to facilitate calculations.

Interest Formulas

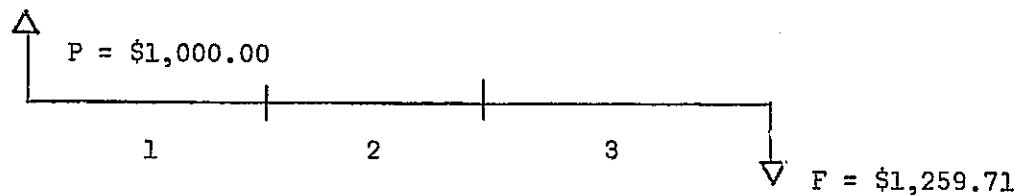
Notation: There has been some work by Canada and others [130] to establish standard notation and symbols for compound interest calculations. Appendix B is a listing of these recommendations as appeared in [130] which will also serve to define the notation and symbols used throughout this particular discussion.

Cash-Flow Diagrams

A cash-flow diagram may be used to clarify or visually represent the relationships of the various benefit and cost streams that occur over the life of a project. For a cash-flow diagram certain conventions seem to be standard:

1. The time scale is represented by a horizontal line with time progressing from left to right.
2. The intervals on the time scale correspond to the interest period, compounding period or annual depending on the particular situation under study. In most situations considered here the interval will represent annual periods unless otherwise noted. The end of the previous interest period is considered to be the beginning of the next.
3. Arrows are used to indicate discrete cash-flows, while shaded areas are used to indicate a continuous cash-flow. An upward arrow or shaded region indicate a positive cash-flow. (Receipt, Income, Benefit). A downward arrow or shaded region indicates a negative cash-flow (Cost, Disbursement, Disbenefit).

The following is a cash-flow diagram of the previous example of time value of money from the borrower's viewpoint.



If the direction of the arrows were reversed, the resultant cash-flow diagram would represent the lender's viewpoint. Therefore, in developing a cash-flow diagram the appropriate viewpoint must be determined to correctly assess the sign associated with the various benefit-cost streams. For private organizations the appropriate viewpoint is not difficult to determine; however, for governmental projects the assessment of the proper viewpoint can be difficult. This will be discussed in detail later on in connection of benefit-cost analysis.

Discrete Compound Interest Formulas

Discrete compounding means that the interest is calculated and added to the principle at the end of each specified interest period. The compounding operation takes place at discrete points spaced at intervals of this specified interest period apart.

There are six discrete interest formulas that are used extensively in managerial and engineering economics:

Factor Name	Factor Formula	Factor Functional Symbol
Single Payment (S.P.)		
S.P. Compound Amount	$(1+i)^N$	$(F/P, i\%, N)$
S.P. Present Worth	$\frac{1}{(1+i)^N}$	$(P/F, i\%, N)$
Uniform Series (Annuities) (U.S.)		
U.S. Compound Amount	$\frac{(1+i)^N - 1}{i}$	$(F/A, i\%, N)$
U.S. Present Worth	$\frac{(1+i)^N - 1}{i(1+i)^N}$	$(P/A, i\%, N)$
Sinking Fund	$\frac{i}{(1+i)^N - 1}$	$(A/F, i\%, N)$
Capital Recovery	$\frac{i(1+i)^N}{(1+i)^N - 1}$	$(A/P, i\%, N)$

The detailed discussion and development of these formulas appear in several well known references [131,132,133,134,135,136,137].

Simple examples with cash-flow diagrams and calculations for each of these factors seem now appropriate for purposes of illustration.

Single Payment Compound Amount Factor

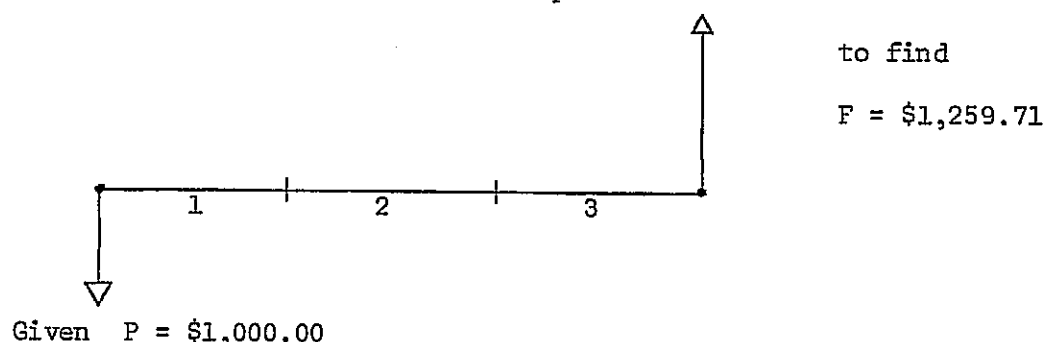
This factor determines the future amount of a given present sum. That is

$$F = P \left[(1 + i)^N \right]$$

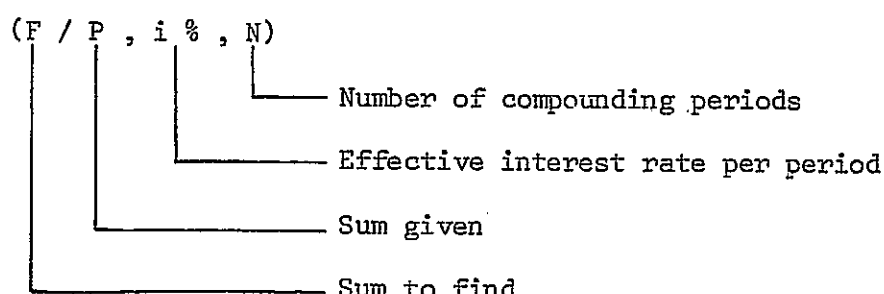
For the previous illustration on time value of money

$$F = \$1,000.00 \left[(1.08)^3 \right] = \$1,259.71$$

The cash-flow diagram from lenders viewpoint is as follows:



The factor functional symbol with explanatory comments common to all factor functional symbols is:



From this it is seen that the principle sum P is given at time zero, i.e. at $t = 0$ (beginning of first interest period), and we want to find F, the future sum at the end of the third interest period.

In symbolic notation this calculation may be stated as follows:

$$F = P (F/P, i\%, N)$$

For convenience Appendix C provides a listing of the numerical values associated with each of these factors for various interest rates and total compounding periods. More complete tables are found in references [132,133,134,135,136,137].

Single Payment Present Worth Factor

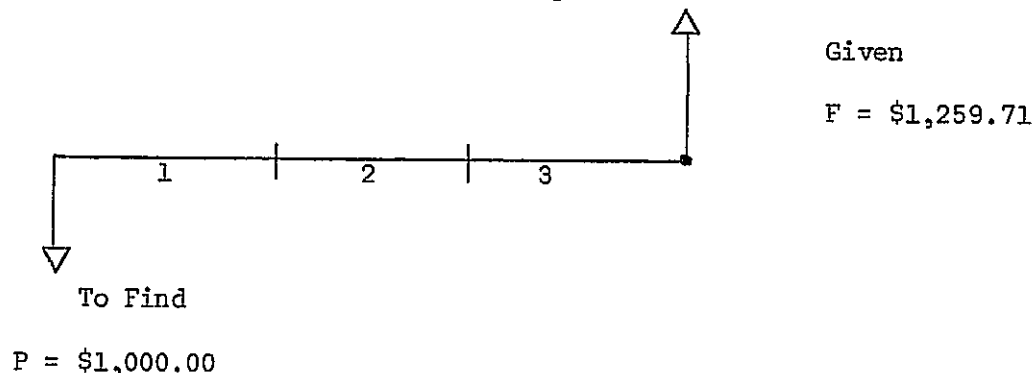
This factor is used to determine the equivalent present worth amount of a given future sum, F. That is

$$P = F \left[\frac{1}{(1 + i)^N} \right]$$

Following the previous example, one has

$$P = \$1,259.71 \left[\frac{1}{(1.08)^3} \right] = \$1,000.00$$

The cash-flow diagram from a lender's viewpoint would be



In symbolic notation this calculation may be stated

$$P = F (P/F, i\%, N)$$

Uniform Series Formulas

The uniform Series or Annuity formulas are used to determine the equivalent uniform series corresponding to either present or future sums or determine the present or future sum equivalent to a uniform series or uniform "cash flows". The uniform series cash flow amounts are assumed to be at the end of each compounding period and continue from the first to the last period. Details of the four uniform series formulas follows:

Uniform Series Compound Amount Factor

This factor is used to determine the future single sum occurring at the end of the last compounding period that is equivalent to a given uniform series occurring at the end of each of the N compounding periods. That is

$$F = A (F/A, i\%, N)$$

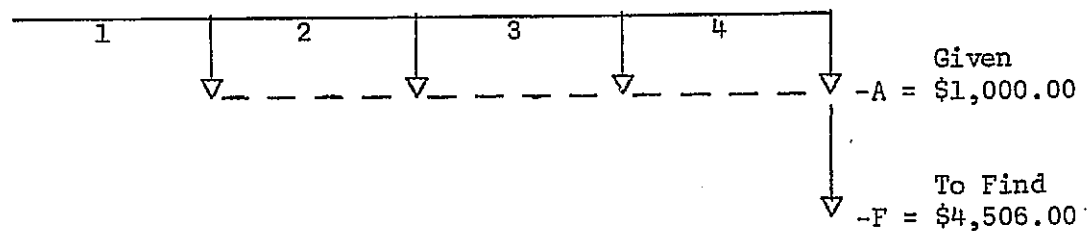
or

$$F = A \left[\frac{(1+i)^N - 1}{i} \right]$$

To illustrate this cash flow diagrams corresponding to the uniform-series calculations consider a situation where the uniform-series consists of \$1,000.00 at the end of each compounding period for four periods. The

effective interest rate for each compounding period is 8%.

The cash-flow diagram from a disbursement point of view would be



$$(F/A, 8, 4)$$

$$F = \$1,000.00 (4.506)$$

$$F = \$4,506.00$$

Uniform Series Present Worth Factor

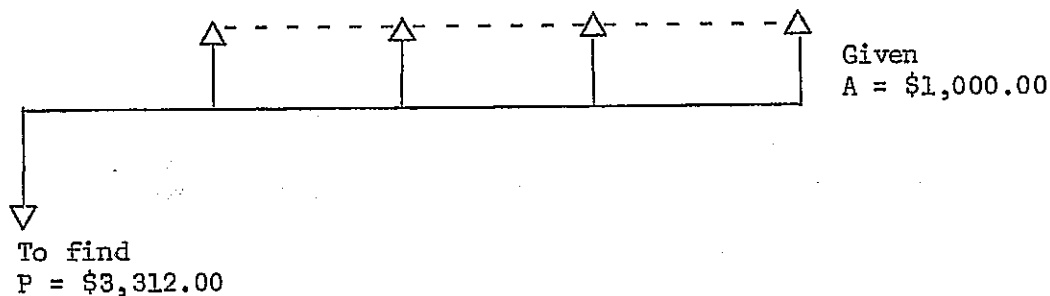
This factor is used to determine the single present sum occurring at time zero that is equivalent to a uniform series amount occurring at the end of each compounding period for N periods. That is

$$P = A (P/A, i\%, N)$$

or

$$P = A \left[\frac{(1+i)^N - 1}{i(1+i)^N} \right]$$

The cash-flow diagram from the standpoint of how much one would have to deposit today to be able to withdraw \$1,000.00 at the end of each year for the next four years would be



$$P = A (P/A, 8, 4)$$

$$P = \$1,000.00 (3.312)$$

$$P = \$3,312.00$$

Sinking Fund Factor

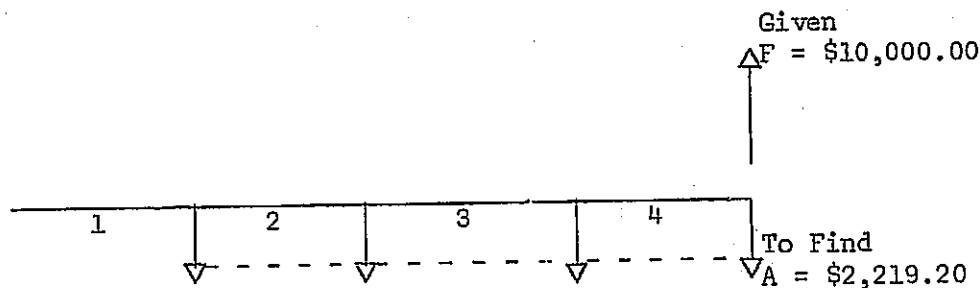
The sinking fund factor is used to determine a uniform series that is equivalent to a future sum occurring at the end of the N^{th} compounding period. That is

$$A = F (A/F, i\%, N)$$

or

$$A = F \left[\frac{i}{(1+i)^N - 1} \right]$$

The factor may be used in calculating depreciation for income tax purposes, where one is determining the amount to depreciate or to be set aside as deposits in a sinking fund at the end of each annual compounding period so that one will have recovered the entire cost of the asset at the end of the N^{th} period. As an example let us determine the amount we would have to deposit so that \$10,000 may be withdrawn at the end of the fourth year. Again assume interest at 8%



$$\begin{aligned} A &= F (A/F, i\%, N) \\ &= \$10,000.00 (.22192) \\ &= \$2,219.20 \end{aligned}$$

Capital Recovery Factor

The capital recovery factor is used to determine a uniform series that is equivalent to a present sum occurring at time zero. That is

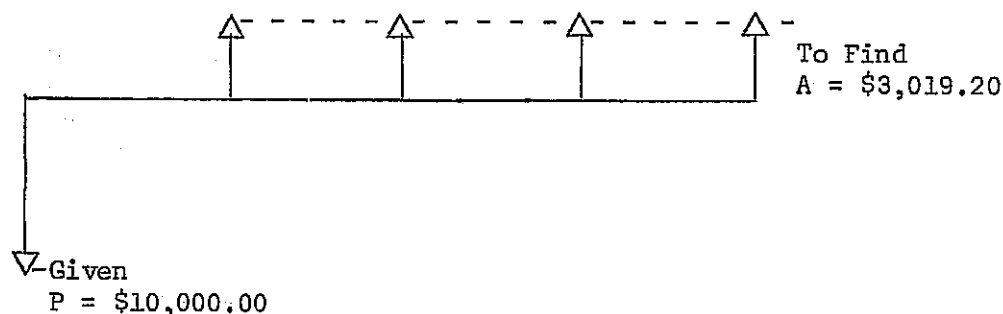
$$A = P (A/P, i\%, N)$$

or

$$A = P \left[\frac{i(1+i)^N}{(1+i)^N - 1} \right]$$

To illustrate the use of this factor assume that one invests \$10,000.00 today in a particular machine. Then, how much income this

machine would have to provide for the next four years in order that at the end of the fourth year all of the capital invested in the machine would be recovered? The cash-flow diagram and calculations for an interest rate of 8% are



$$A = P (A/P, 8, 4)$$

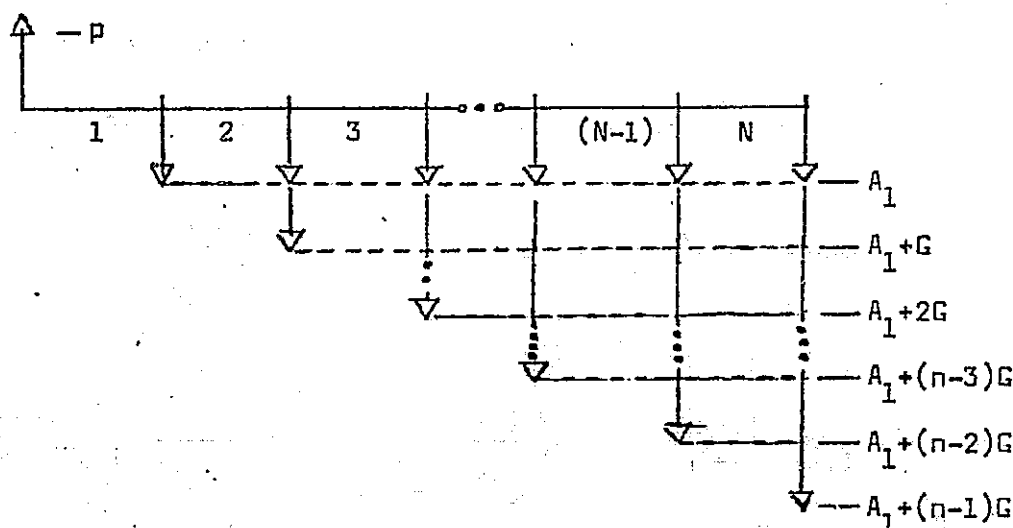
$$A = \$10,000.00 (0.30192)$$

$$A = \$ 3,019.20$$

When the cash flows are not uniform i.e. if the series are non-uniform, then there are three common approaches that can be used.

1. Gradient Series

If the change in the per-period amount is linear the progression is arithmetic and the gradient interest factor values of Appendix D may be used in equivalence calculations. A general cash-flow diagram representing this situation is:



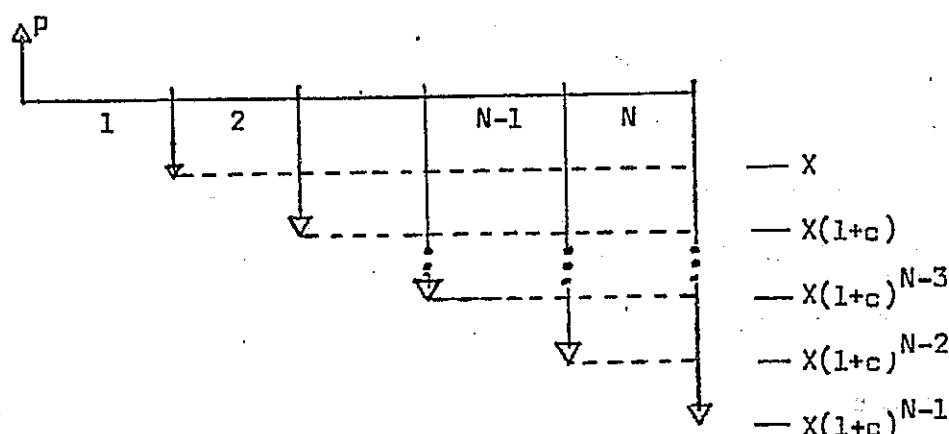
To convert this cash flow diagram to an equivalent uniform series, the following relationship is used.

$$A = A_1 + G(A/G, i\%, N)$$

Note that interest factor $(A/G, i\%, N)$ converts a linearly increasing series, increasing by G each period beginning at the end of the second period, into a uniform series which begins at the end of first period. Appendix B gives the interest factor values of $(F/G, i\%, N)$; $(P/G, i\%, N)$ and $(A/G, i\%, N)$ for various $i\%$'s and N 's.

2. Exponential Series

If the change in the per-period amount is exponential, the progression is geometric and with modifications the interest factor values of Appendix B may be used in equivalence calculations. As an example consider the situation in which the increase is at a constant rate of increase say $c\%$. Thus if X is the sum at the end of the first period the cash-flow representation would be.



To find P of this series the interest factor values of Appendix C may be used. Thus

$$P = X \left(\frac{1}{1+i} \right) + X \left(\frac{1+c}{(1+i)^2} \right) + \dots + X \left(\frac{(1+c)^{N-1}}{(1+i)^N} \right)$$

This can be multiplied and divided by $(1+c)$ so that

$$P = \frac{X}{(1+c)} \left(\frac{1+c}{1+i} \right) + \frac{X}{1+c} \left(\frac{(1+c)^2}{(1+i)^2} \right) + \dots + \frac{X}{(1+c)} \left(\frac{(1+c)^N}{(1+i)^N} \right)$$

or

$$P = \frac{X}{1+c} \left[\left(\frac{1+c}{1+i} \right) + \left(\frac{1+c}{1+i} \right)^2 + \dots + \left(\frac{1+c}{1+i} \right)^N \right]$$

For the situation where $c > i$ let

$$\left(\frac{1+c}{1+i}\right) = 1+y$$

whereby $P = \frac{X}{1+c} [(1+y) + (1+y)^2 + \dots + (1+y)^N]$

None $[1 + (1+i) + (1+i)^2 + \dots + (1+i)^{N-1}] = \frac{(1+i)^N - 1}{i}$

or $(F/A, i\%, N)$.

Then
$$P = X \left(\frac{1+y}{1+c}\right) (F/A, y\%, N)$$

$$= \frac{X}{1+i} (F/A, y\%, N).$$

For the situation $c < i$ let

$$\frac{1+c}{1+i} = \frac{1}{1+y}$$

Then
$$P = \left[\frac{X}{1+c}\right] \left[\frac{1}{1+y} + \left(\frac{1}{1+y}\right)^2 + \dots + \left(\frac{1}{1+y}\right)^N\right]$$

But
$$\left[\frac{1}{1+i} + \left(\frac{1}{1+i}\right)^2 + \dots + \left(\frac{1}{1+i}\right)^{N-1}\right] = \frac{(1+i)^N - 1}{i(1+i)^N}$$

or $(P/A, i\%, N)$.

Therefore $P = \left(\frac{X}{1+c}\right) (P/A, y\%, N)$

When $c = i$ then

$$P = \frac{X}{1+c} (N) = \frac{NX}{1+c}$$

Thus with slight modifications one may use the interest factors of Appendix C to convert end of period sums increasing at a constant rate into an equivalent present worth.

3. Variable end-of-period Sums

For variable end-of-period amounts each sum must be treated individually using Appendix C formulas. That is, to find

the present-worth of a non-uniform series each individual sum would be discounted to the present and summed to form the total present-worth. This total present-worth could then be made equivalent to an equal annual series if that information was desired.

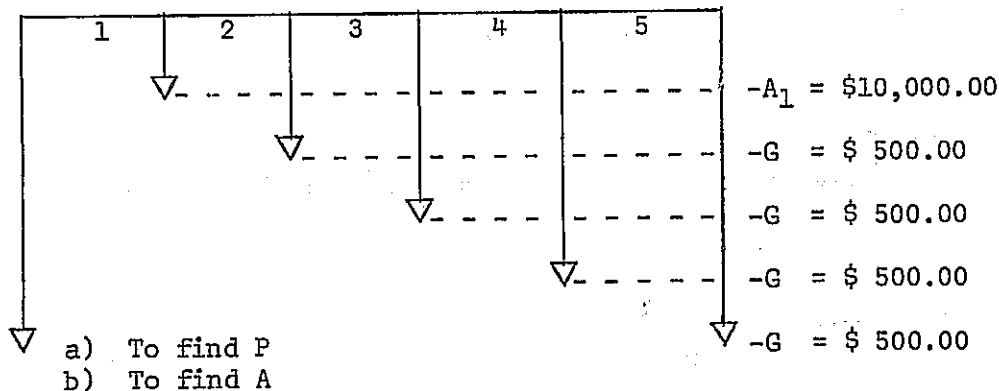
Examples of each of these non-uniform series calculations follows:
Example -- Gradient Series

Consider a situation in which the operating costs of a particular machine is estimated to be \$10,000 for the first year and increases by \$500 per year for the next four years.

- Determine the equivalent present-worth of this series of operating costs.
- Determine the equivalent uniform annual cost of this series of operating costs.

Assume the cost of capital is 10%.

The cash-flow diagram would be:



$$a) P = A_1(P/A, i\%, N) + G(P/G, i\%, N)$$

$$P = \$10,000 (3.791) + \$500 (6.862)$$

$$= \$37,910.00 + \$3,431.00$$

$$= \$41,341.00$$

$$b) A = A_1 + G(A/G, i\%, N)$$

$$A = \$10,000.00 + \$ 500 (1.810)$$

$$= \$10,000.00 + \$ 905.00$$

$$= \$10,905.00$$

One might check this with a rounding error to be

$$\begin{aligned}
 P &= A(P/A, i\%, N) \\
 &= \$10,905.00 (3.791) \\
 &= \$41,340.86
 \end{aligned}$$

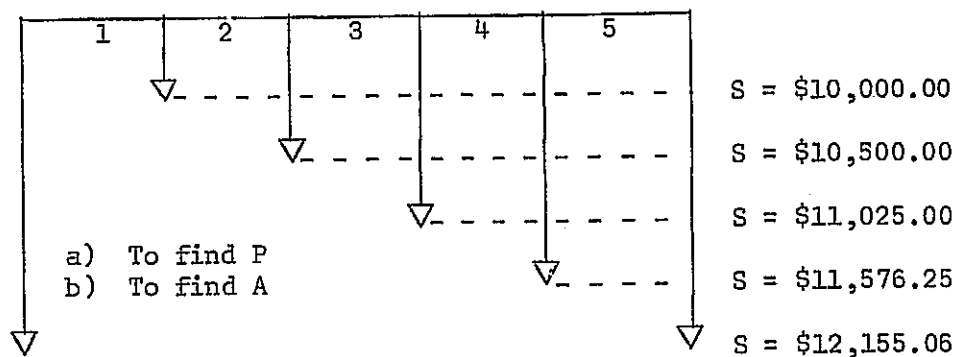
Example -- Exponential Series

Consider a situation in which the operating costs of a particular machine is estimated to be \$10,000 for the first year and increases by 5% of the previous years operating costs for the next four years.

Assume the cost of capital is 10%.

- Determine the equivalent present-worth of this series of operating costs.
- Determine the equivalent annual-cost of this series of operating costs.

The cash-flow diagram would be:



- For the situation where $c < i\%$ we have

$$\begin{aligned}
 \frac{1 + 0.05}{1 + 0.10} &= \frac{1}{1 + y} \\
 (0.95454)(1 + y) &= 1 \\
 y &= 0.0476
 \end{aligned}$$

$$\begin{aligned}
 \text{Now } P &= \left(\frac{X}{1+c} \right) (P/A, y\%, N) \\
 &= \left(\frac{10,000}{1.05} \right) \left[\frac{(1.0476)^5}{(0.0476)(1.0476)^5} \right] \\
 &= (9523.81) \left[\frac{0.26173}{0.06005} \right] \\
 &= (9523.81) [4.35853] \\
 &= \$41,509.81
 \end{aligned}$$

- b) This present-worth may be converted into an equivalent equal annual sum by

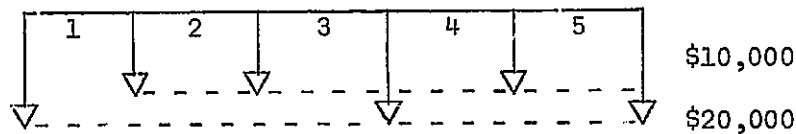
$$A = P(A/P, i\%, N)$$

$$A = \$41,509.81 (0.26380)$$

$$A = \$10,950.29$$

Example --- Non-Systematic Series

Consider the following cash-flow diagram representing costs that are estimated to occur during the next five years of a projects life.



Assume the cost of capital is 10%

- Determine the equivalent present-worth of this non-systematic series.
- Determine the equivalent equal annual series of this non-systematic series.

$$\begin{aligned}
 a) \quad P &= P_1 + A(p/A, i\%, N) + S_1(P/S, i\%, n_1 = 3) \\
 &\quad + S_2(P/S, i\%, n_2 = 5) \\
 &= \$20,000 + \$10,000(3.791) + 10,000(0.7513) + 10,000(0.6209) \\
 &= \$71,632
 \end{aligned}$$

$$\begin{aligned}
 \text{b) } A &= A_1 + [P_1 + S_1(P/S, i\%, n_1 = 3) \\
 &\quad + S_2(P/S, i\%, n_2 = 5)](A/P, i\%, N) \\
 &= \$10,000.00 + [20,000.00 + 10,000.00 (0.7513) \\
 &\quad + 10,000.00 (0.6209)] (0.26380) \\
 &= \$18,895.86
 \end{aligned}$$

Using a combination of these methods it is possible to transform any series of discrete amounts into a present-worth, an equal annual amounts or a future worth that will be equivalent to the original series at the prescribed rate of interest.

The discrete interest formulas may also be used for more frequent than annual compounding periods as long as the discrete cash flows are assumed to coincide with the end or beginning of a compounding period. For instance if the compounding is quarterly ($M=4$), the nominal or annual interest rate is $r\%$ and the project extends for n years, the appropriate interest factor value would be determined using $i\% = r\%/M$ and $N = nM$. Thus we see that the effective interest rate per interest period is the nominal or annual interest rate divided by the number of compounding periods per year, where as the number of interest periods is determined by multiplying the number of years estimated to be the life of the project.

Continuous Compounding. (Discrete Cash Flow)

When the length of the compounding period is less than one year the interest rate corresponding to an annual interest rate of $r\%$ is $i\% = r\%/M$ where M is the number of compounding periods per year. The single payment present worth and compound amount factors become

$$\text{S.P. Present Worth} \quad \left[\frac{1}{1 + \frac{r}{M}} \right]^{MN}$$

$$\text{S.P. Compound Amount} \quad \left[1 + \frac{r}{M} \right]^{MN}$$

Let $k = \frac{M}{r}$ and substituting in the S.P. Compound Amount factor

$$\text{S.P. Compound Amount} \quad \left[1 + \frac{1}{k} \right]^{rkN}$$

which may be expressed as

$$\left[1 + \frac{1}{k} \right]^k {}^{rN}$$

Now as $M \rightarrow \infty$ k would $\rightarrow \infty$ and $(1 + \frac{1}{k})^k \rightarrow e$, which is the base of the natural logarithms (2.71828+). Therefore when the number of compounding periods increases the form of the limiting interest formulas become

S.P. Compound Amount	e^{rN}	(F/P, $r\%$, N)
S.P. Present Worth	e^{-rN}	(P/F, $r\%$, N)
U.S. Compound Amount	$\frac{e^{rN} - 1}{e^r - 1}$	(F/A, $r\%$, N)
U.S. Present Worth	$\frac{e^{rN} - 1}{e^{rN}(e^r - 1)}$	(P/A, $r\%$, N)
U.S. Sinking Fund	$\frac{e^r - 1}{e^{rN} - 1}$	(A/F, $r\%$, N)
U.S. Capital Recovery	$\frac{e^{rN}(e^r - 1)}{e^{rN} - 1}$	(A/P, $r\%$, N)

A listing of the values of these factors for certain $r\%$ and N is given in Appendix E.

These factors correspond to continuous compounding applied to discrete cash flows and would be used in the same situations as the formulas and values of Appendix C. As a comparison of these methods let us consider a situation in which the Present Worth of the following cash flow diagram is required. Assume the Cost of Capital is 10% per annum.

a Discrete Compounding — (one compounding period per year).

$$P = -30,000 + [(10,000 - 20,000) + (20,000 - 10,000)] \frac{1}{(P/A, 10\%, 4)} \frac{1}{(P/F, 10\%, 1)}$$

$$P = -30,000 + [-10,000 + 10,000 (3.1699)] [0.9091]$$

$$P = -10,316.84$$

b Continuous Compounding — (discrete cash flow).

$$P = -30,000 + [(10,000 - 20,000) + (20,000 - 10,000)] \frac{1}{(P/A, 10\%, 4)} \frac{1}{(P/F, 10\%, 1)}$$

$$= -30,000 + [-10,000 + 10,000 (3.1347)] [0.9048]$$

$$P = -10,685.23$$

It is interesting to note that continuous compounding - discrete cash flows differ from discrete compounding only in the values of the interest

factors - and hence the magnitude of the value of the final present worth determined.

Continuous Compounding - (Continuous Cash Flow)

It is possible to average out discrete cash flows into continuous cash flows. This is equivalent to saying that there are, a , distinct cash flows per year. With the nominal interest rate of $r\%$ and the, a , distinct cash flows amounting to a total of 1 unit per year, the present worth of this flow of, a , distinct flows would be:

$$P = \frac{1}{a} \left[\frac{[1 + (\frac{r}{a})]^a - 1}{\frac{r}{a} [1 + (\frac{r}{a})]^a} \right]$$

$$= \frac{[1 + (\frac{r}{a})]^a - 1}{r [1 + (\frac{r}{a})]^a}$$

Using the same approach as in the previous section when $a \rightarrow \infty$ then $(1 + \frac{r}{a})^a \rightarrow e^r$ as the single payment present worth factor corresponding to 1 unit per year flowing continuously is

$$\frac{e^r - 1}{re^r} \quad \text{or} \quad e^{-r} \left[\frac{e^r - 1}{r} \right]$$

Extending this for more than one year and using the notation of \bar{A} to indicate the amount flowing each year for N years the continuous compounding present worth factor for continuous cash flows is

$$\frac{1}{a} \left[\frac{[1 + \frac{r}{a}]^{aN} - 1}{(\frac{r}{a}) [1 + \frac{r}{a}]^{aN}} \right]$$

and letting $a \rightarrow \infty$ would yield

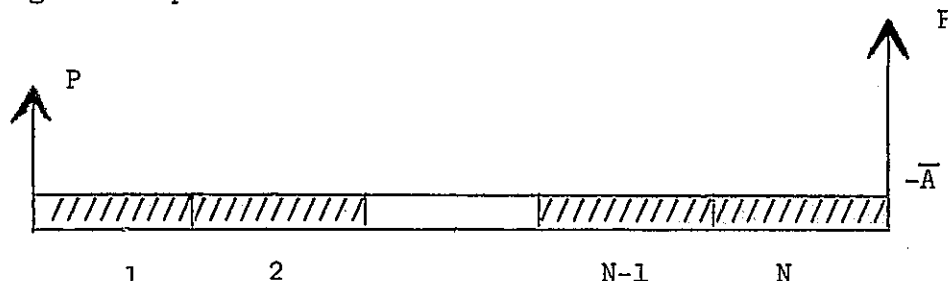
$$(P/\bar{A}, r\%, N) = \frac{e^{rN} - 1}{re^{rN}}$$

The resultant interest factors are

Continuous Compounding Compound Amount Factor (continuous uniform cash flow)	$\frac{e^{rN} - 1}{r}$	$(F/\bar{A}, r\%, N)$
Continuous Compounding Present Worth Factor (continuous uniform cash flow)	$\frac{e^{rN} - 1}{re^{rN}}$	$(P/\bar{A}, r\%, N)$
Continuous Compounding Sinking Fund Factor (continuous uniform cash flow)	$\frac{r}{e^{rN} - 1}$	$(\bar{A}/F, r\%, N)$
Continuous Compounding Capital Recovery Factor (continuous uniform cash flow)	$\frac{re^{rN}}{e^{rN} - 1}$	$(\bar{A}/P, r\%, N)$

A listing of these factor values for certain $r\%$ and N is given in appendix F.

The general cash flow diagram representing continuous cash flows might be represented as



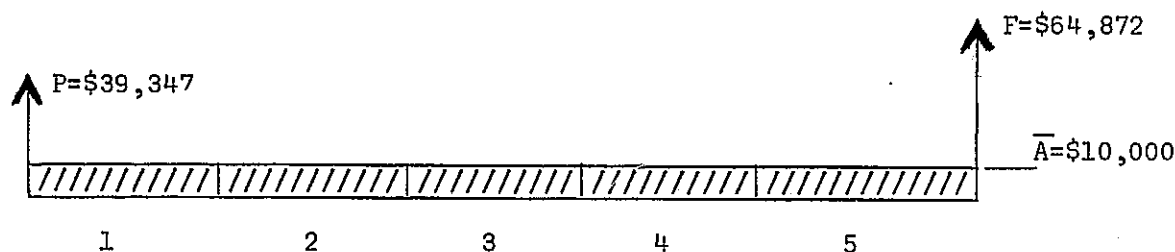
An example of this type of compounding scheme would be as follows:

Determine the single payment present worth (future worth) of 5 years of uniform, continuous cash flow, flowing at the rate of \$10,000 per year. ($A = \$10,000$, $N = 5$) Assume the cost of capital is 10%.

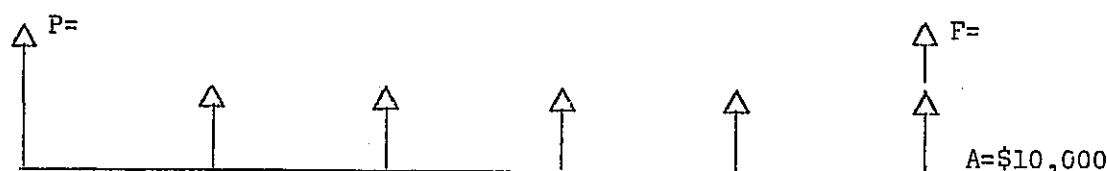
$$\begin{aligned}
 P &= \bar{A} (P/\bar{A}, r\%, N) \\
 &= \$10,000 (3.9347) \\
 &= \$39,347
 \end{aligned}$$

$$\begin{aligned}
 F &= \bar{A} (F/\bar{A}, r\%, N) \\
 &= \$10,000 (6.4872) \\
 &= \$64,872
 \end{aligned}$$

The cash flow diagram would be



Using discrete compounding with discrete cash flows the equivalent cash flow diagram of this example would be



$$P = A (P/A, r\%, N)$$

$$P = \$10,000 (3.7908)$$

$$P = \$37,908$$

$$F = A (F/A, r\%, N)$$

$$F = \$10,000 (6.1051)$$

$$F = \$61,051$$

Although the discrete cash flow models with discrete discounting seem to prevail in the practice of the managerial and engineering economics, nevertheless, considerable flexibility and mathematical simplicity could be gained by going to continuous cash flow models with continuous discounting [139,140]. This latter approach does relate to calculus and operational mathematics which are less appreciated by conventional managers than the usual familiar arithmetic operations established through conventions of the past.

It seems appropriate now to introduce some important accounting conventions in terms of continuous cash flows with continuous discounting. The notation will be changed for this purpose as follows: K will be the total volume of sacrifice or outlay in dollars; N will be the expected total volume of benefit in dollars; $n(t)$ will denote the expected net returns or benefit cash flow in dollars/annum. $\delta(t)$ is the

unit impulse function. With such a notation the following important accounting and investment criteria are introduced:

1. Payback Period Criterion

Definition: Payback period is the time period required to recover the initial cash outlay from the net returns yielded by the respective acquired asset.

Figure 19 illustrates two ventures each having the same payback period but obviously different total impact on profitability. Let $n(t)$ be the net returns cash flow in \$/annum, K the initial investment in \$, and T_{pb} the payback period

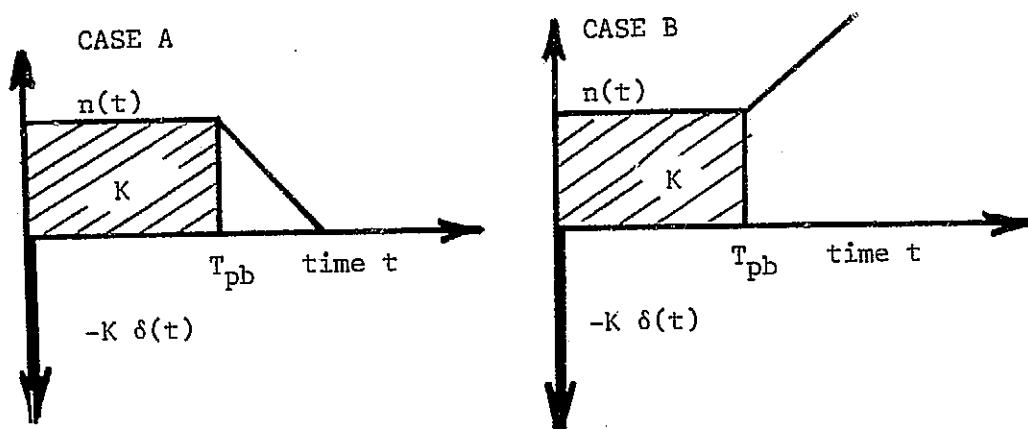


Figure 19. Two different net return flows $n(t)$ for same outlay K and identical payback periods T_{pb} .

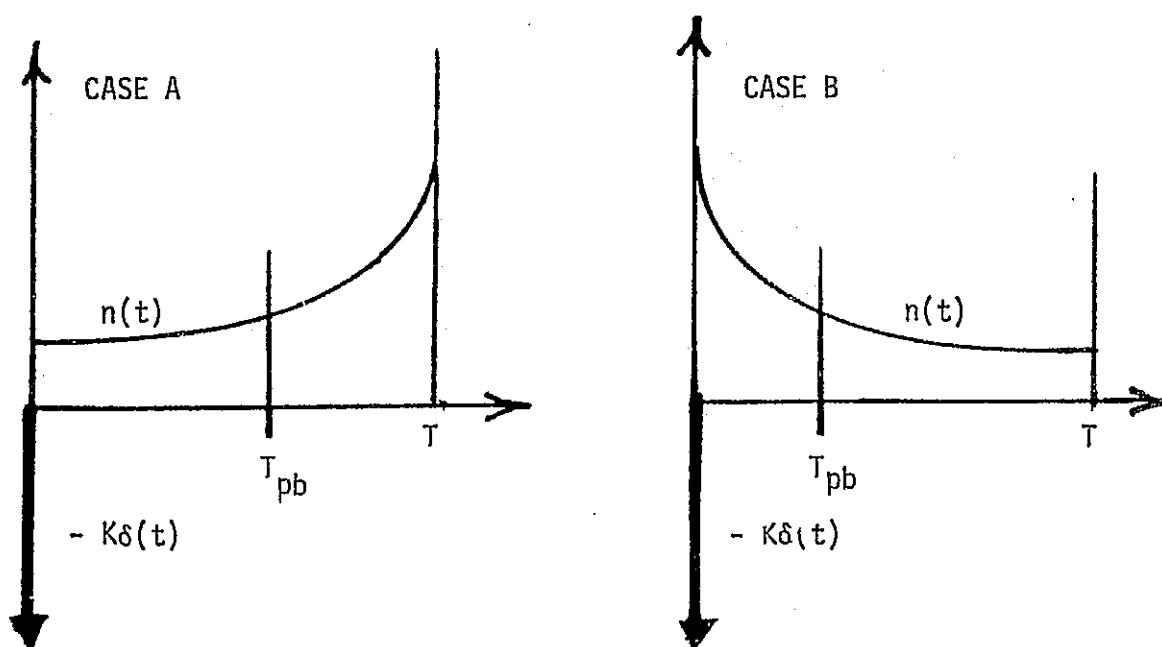
In these examples the shaded areas under the $n(t)$ curve add up to the outlay of K dollars at the identical payback period T_{pb} but with obviously different net return flows $n(t)$. The case B is obviously preferable to the case A, but the payback period method is incapable to make this distinction. Hence, it is not necessarily a "good" method to be used in many cases.

2. Accounting Rate of Return Criterion

Definition: The accounting rate of return is defined as the average increase in the annual net income contributed by the asset divided by the initial or average outlay in the asset.

Figure 20 illustrates two different cases with identical accounting rates of return.

Figure 20. Two different net return flows $n(t)$ for same outlay K and same accounting rate of return but different payback periods T_{pb} .



In this illustration the payback period is shorter for the case B than for the case A while the accounting rate of return

$$\left[\frac{1}{T} \int_0^T n(t) dt \right] / K$$

is the same for the two alternatives. The accounting rate of return criterion is incapable of discriminating between these two alternatives while the payback period criterion will do so in favor of the case B.

3. The Internal Rate of Return Criterion

Definition: Let K be the net dollar outlay for an asset at the time $t = 0$. Let $n(t)$ be the expected net returns flow from the asset over its life T . Let J be the residue or junk value of the asset at the time $t = T$. Then the internal rate of return r is that discount rate which discounts the future net value of the asset to be equal to the current outlay:

$$K = \int_0^T n(t) e^{-rt} dt + J e^{-rT}$$

This concept can be generalized to the cases where the investment in the asset is distributed over time. The internal rate of return is an

"intrinsic" property of the asset performance, revenues and costs. The asset must have an internal rate of return equal to or greater than the going interest rate or "cost of capital" in the capital markets. The higher this internal rate of return is above the going interest rate or cost of capital the more desirable is the venture. Therefore, this criterion recognizes fully the time value of money.

4. The Net Present Value Criterion

Definition: Let $n(t)$ be the expected net returns flow for a venture over its life T , and let J be the residue or junk value of this asset. Let r' be prevailing interest rate or cost of capital. Then the present value P of the asset is equal to the r' discounted future value of the asset:

$$P = \int_0^T n(t) e^{-r't} dt + J e^{-r'T}$$

Further, let K be the outlay for the asset at the time $t = 0$. Then the profitability index of this asset is defined as follows:

$$\alpha = P/K = \left[\int_0^T n(t) e^{-r't} dt + J e^{-r'T} \right] / K$$

In order that the project be acceptable, the profitability index must be greater than unity. Further, the higher α is, the more desirable is the project.

So long the outlays and net returns are measured in the same value units, these criteria will be applicable. In particular, they apply to benefit-cost analysis so long the benefits and costs are measured in the same units. In particular, benefits and costs might not be measured in terms of dollars. It is also possible to associate with a project several different benefit-cost streams so that one ends up with a multidimensional value system.

The conventional managerial and engineering economics concepts discussed here may not provide an appropriate approach to situations where there are a number of different projects which have, however, strong interrelationships and synergies. In such cases a broader systems approach is needed to analyze all "direct" and "indirect" effects. For example, if one takes an overtly "atomistic" approach and finds that one of the projects has a zero internal rate of return while the other projects have very high rates of returns. But if this zero rate of return project is eliminated, its impact on other projects may lower their rates of return considerably. Benefit-cost analysis is likely to encounter these kinds of situations. A particular public project may have a very low rate of return, but it could conceivably induce benefits on other public and private activities thereby increasing their profitabilities rather considerably.

One can develop with continuous cash-flow - continuous discounting concepts a parametric modeling approach to investment and benefit-cost analysis [139,140]. Appendix A provides an approach and a number of illustrations how this is done. Various financial and performance parameters are introduced to shape the expected sacrifice and benefit flows for a venture. For example, parameters for the forces of mortality and renovation or innovation for a project could be introduced. Thus the concept of a project life-cycle could be incorporated into the venture analysis. Further, the parameters could be treated as random variables whereby uncertainty and risk analysis can also be incorporated into such analysis.

Remarks On Decision Criteria

The various accounting and investment criteria discussed previously are commonly used as decision criteria in conjunction with the volume of net benefits or the volume of net sacrifices in selecting "best alternatives" from a set of feasible alternatives. Typically, however, investment decisions in managerial and engineering economics are more complicated than this kind of an evaluation process. This is particularly true if one deals with new technology, new products and/or new processes with unknown or untested market characteristics and market potential. The planning-decision process required here is typically "multi-disciplinary" involving hopefully an effective systems approach in searching out the "best alternatives".

Hall [141] lists five phases of a systems approach:

- Systems Studies
- Exploratory Planning
- Development Planning
- Studies During Development
- Current Engineering

The second phase, Exploratory Planning, is primarily concerned with choosing a cause of action from among the possible alternatives under consideration. To operationalize the second phase Hall establishes six problem solving functions which may be applied to the study of any problem solving situation.

The problem definition is defined as follows [141]:

"Problem definition is isolating, possibly quantifying, and relating the set of factors which will define the system and its environment. Since a problem is an outward expression of an unsatisfied need, the job is to find what the need really is. This means gathering and analyzing data to describe the operational situation, customer requirements, economic considerations, policy, possible system inputs and outputs, etc."

In particular, it should be noted that marketing research must enter into the planning-decision process in this stage.

The second function is Selecting Objectives:

"Selecting objectives is the logical end of problem definition. The objectives chosen guide the search for alternatives, imply the types of analyses required of the alternatives, and provide the criteria for selecting the optimum system."

This function generates decision criteria which are going to be used in the subsequent decision making processes for the selection of the "optimum system". The selection of decision criteria will depend on the particular project and objectives chosen. In this discussion consideration is given to the economic aspects of a project so that the decision criteria will be expressed in monetary terms. If the economic aspects of the project are known or assumed with certainty, deterministic criteria such as present worth, annual worth, rate of return, pay-out period, capitalized amount or benefit-cost ratio may be used. If the economic aspects of the project are not known with certainty, but knowledge is available about the possible probability distributions of inputs and/or outputs, then expected values in conjunction with the respective variances may be used to establish above types of criteria. If knowledge of the probability distributions of inputs and/or outputs are not available, sensitivity analysis may be used to provide information on how the above decision criteria respond to variation in certain input, conversion and/or output parameters. In this regard, care must be taken on how parametric modeling is done to describe the "real world" situations under consideration. Game theory has also been used to establish appropriate input and/or output parameter values if knowledge is available concerning the various possible states of the parameters and whether the decision maker is optimistic, pessimistic or some combination of these. However, some question must be raised about the realism of the usual game-theoretical assumptions in real life situations of conflicts involving possibly several interest groups.

The third problem solving function [141] is Systems Synthesis:

"Systems synthesis entails compiling or inventing alternative systems which can satisfy the objectives. Each alternative must be worked out in enough detail to permit its subsequent evaluation with respect to the objectives and to permit a decision as to its relative merits for possible development."

It is important to realize that this phase exploratory planning of systems engineering is a predecision analysis so that the freest possible imagination should be used in problem definition and systems synthesis. The degree of detail utilized in input-output determination should be such as to allow a meaningful decision-process. Cost and time required for this function must be kept under control.

The fourth problem solving function, System Analysis, is defined as follows:

"Systems analysis means deducing the consequences of the entire list of hypothetical systems. The deductions relate to system performance, cost, quality, market, etc."

The Fifth and sixth functions [141] areas follows:

"Selecting the best system involves evaluating the analyses and comparing these evaluations with the objectives to select the smallest possible subset of alternative systems which merit further study.

Communicating results is the final function in this phase. The function may call for a formal report which draws one of three conclusions: (1) that specific development will solve the problem, (2) that exploratory development in the laboratory is needed on particular alternatives before a sound conclusion can be reached, or (3) that no further work is justified at this time."

The selection of the "best system" will be done in forms of the optimum decision criteria value if input-output characteristics are known with certainty. Techniques utilizing the calculus of optimization may be used under certainty conditions. For conditions of uncertainty there is no general method for comparing alternatives. As a special example, consider the following procedure outlined in the reference [141].

Consider a decision-process that has n alternatives A_1, A_2, \dots, A_n ; each one with m components. O_1, O_2, \dots, O_m . For simplicity assume that the cost of each component may be expressed in monetary terms. However the cost is uncertain and follows a particular probability density function, $g_{ij}(x)$ that has a finite expected value and variance. For example the expected value and the variance of the j th componet of the i th alternative may be expressed as E_{ij} and σ^2_{ij} . Assume also that the costs associated with each alternative component is independent of all other costs. With these assumptions the total expected cost of each alternative may be expressed as a linear combinations of the expected component costs that are present in the alternative. The variance of the total cost is also a linear combination of the component variances. In tabular form these are:

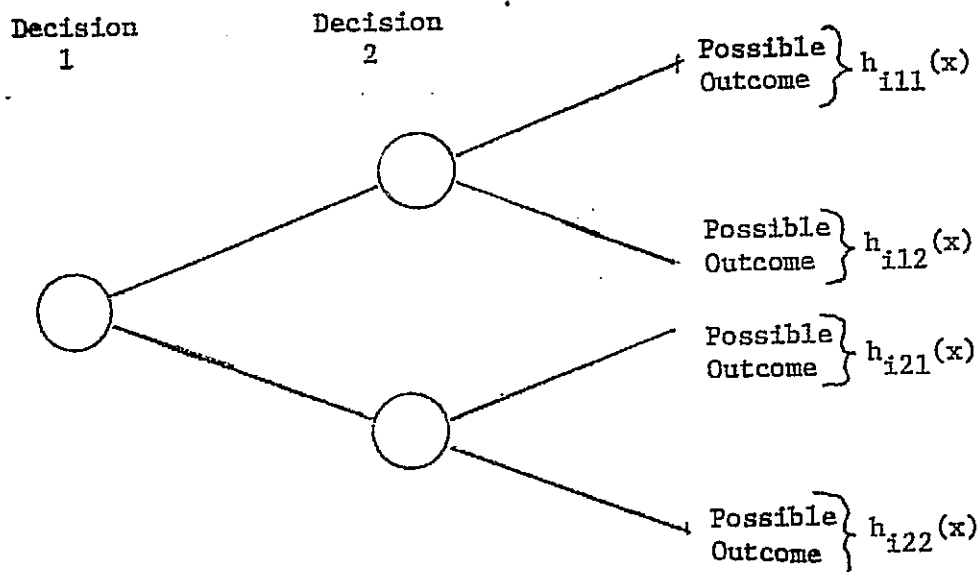
Alternative	Component Mean and Variance				Alternative Mean and Variance
	μ_1	μ_2	\dots	μ_m	
A_1	E_{11}	E_{12}	\dots	E_{1m}	$E_1 = \sum_{j=1}^m E_{1j}$
	σ_{11}^2	σ_{12}^2	\dots	σ_{1m}^2	$\sigma_1^2 = \sum_{j=1}^m \sigma_{1j}^2$
A_2	E_{21}	E_{22}	\dots	E_{2m}	$E_2 = \sum_{j=1}^m E_{2j}$
	σ_{21}^2	σ_{22}^2	\dots	σ_{2m}^2	$\sigma_2^2 = \sum_{j=1}^m \sigma_{2j}^2$
\vdots	\vdots	\vdots		\vdots	\vdots
A_n	E_{n1}	E_{n2}	\dots	E_{nm}	$E_n = \sum_{j=1}^m E_{nj}$
	σ_{n1}^2	σ_{n2}^2	\dots	σ_{nm}^2	$\sigma_n^2 = \sum_{j=1}^m \sigma_{nj}^2$

The probability density function associated with the total cost of each alternative, $g_i(x)$, may be determined from the convolution of the linear combination of the component density functions. For large m , $g_i(x)$ would tend to the normal density function with mean E_i and variance σ_i^2 . For small m and discrete probability functions the actual convolution procedure should be used. This convolution procedure is discussed in the references [142,143].

This procedure will provide to the decision-maker a set of probability density functions that may be used for various comparisons of the alternatives. These comparisons could be done by ranking the expected values, E_{ij} , evaluating the probability of the costs being less than or greater than a particular value, etc. If sequential decisions are required during the life of the project, decision-tree techniques may be

used in conjunction with the above procedure. This method would establish a probability density function for each of the possible outcomes associated with the project. A simple decision-tree may be represented by:

Figure 21.



The decision-maker would then optimize on the decision criteria for each of the n alternatives and then optimize between the n alternatives.

If independence of the random variables associated with each of the component probability density functions cannot be assumed, the problem of convolution becomes more difficult and knowledge of the co-variance of the components is required: Such a case is not treated in detail in this discussion. This subject is discussed in references [144,145,146].

For the previously introduced decision criteria, certain simplifying assumptions are in order. These are:

1. The monetary benefits and cost associated with each of the alternatives is flowing discretely at the end of each year for the N years of the project life. The $N+1$ benefit and cost streams will be represented by B_k and C_k for $k = 0, 1, 2, \dots, N$. The i^{th} and j^{th} subscript corresponding to the i^{th} alternative and j^{th} component have been omitted.
2. Annual compounding is assumed at $r\%$ nominal rate.

With these assumptions the decision criteria may be detailed as follows:

1. Present Worth (P.W.)

Present worth is defined to be the sum at time zero that is equivalent to a particular cash flow of benefits and/or costs. Under the assumptions above the P.W. may be represented by:

a) P.W. of Benefits

$$P.W. = B_0 + \sum_{k=1}^N B_k \left(\frac{1}{1+r} \right)^k$$

b) P.W. of Costs

$$P.W. = C_0 + \sum_{k=1}^N C_k \left(\frac{1}{1+r} \right)^k$$

c) P.W. of Net Benefits (benefits minus costs)

$$P.W. = (B_0 - C_0) + \sum_{k=1}^N (B_k - C_k) \left(\frac{1}{1+r} \right)^k$$

$\left(\frac{1}{1+r} \right)^k$ is the discrete compounding present worth factor (P/F, r%, k) whose values are given in Appendix C.

2. Annual Worth (A.W.)

Annual worth is defined to be the uniform annual sum that is equivalent to a particular cash flow of benefits and/or costs. Annual worth may be represented by:

a) A.W. of Benefits

$$A.W. = \left[B_0 + \sum_{k=1}^N B_k \left(\frac{1}{1+r} \right)^k \right] \left[\frac{r(1+r)^N}{(1+r)^N - 1} \right]$$

b) A.W. of Costs

$$A.W. = \left[C_0 + \sum_{k=1}^N C_k \left(\frac{1}{1+r} \right)^k \right] \left[\frac{r(1+r)^N}{(1+r)^N - 1} \right]$$

c) A.W. of Net Benefits

$$A.W. = \left[(B_0 - C_0) + \sum_{k=1}^N (B_k - C_k) \left(\frac{1}{1+r} \right)^k \right] \left[\frac{r(1+r)^N}{(1+r)^N - 1} \right]$$

In symbolic notation these become

$$A.W. = P.W. (A/P, r\%, N)$$

where $(A/P, r\%, M)$ is the capital recovery factor whose value is found in Appendix C.

3. Rate of Return (R.R.)

Rate of return is defined as the interest rate that results in equality between the cash flow of benefits and the cash flow of costs. The cash flows may be expressed in their equivalent forms such as P.W. or A.W.. The procedure then is to determine $i\%$ such that

$$B_0 + \sum_{k=1}^N B_k \left(\frac{1}{1+i} \right)^k = C_0 + \sum_{k=1}^N C_k \left(\frac{1}{1+i} \right)^k$$

or

$$\left(B_0 - C_0 \right) + \sum_{k=1}^N (B_k - C_k) \left(\frac{1}{1+i} \right)^k = 0$$

If the sign associated with $(B_k - C_k)$ changes more than once for $k = 0, 1, 2, \dots, N$, there is no unique solution for i . One can introduce additional relevant assumptions which, if sufficient in number and kind, would allow a unique determination of i . In this regard, the continuous benefit-cost flow models with continuous discounting in conjunction with a set of appropriate limiting conditions can greatly simplify the problem of finding a unique discount rate i [139].

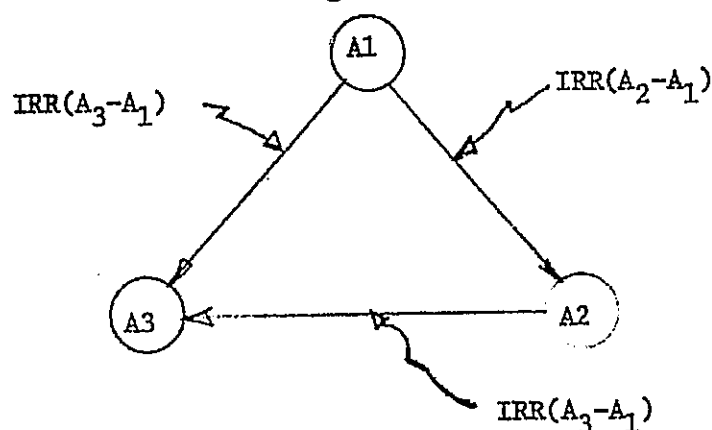
The rate of return on the incremented investment requirements may be used in choosing which mutually exclusive alternative to accept. For example, consider three alternatives A_1, A_2 and A_3 with first costs FC_1, FC_2 and FC_3 such that $FC_1 < FC_2 < FC_3$. Establish a minimum acceptable rate of return, say MRR. Then calculate RRA_1 such that

$$B_{10} - C_{10} + \sum_{B=1}^N (B_{1k} - C_{1k}) \left(\frac{1}{1+i} \right)^k = 0$$

If $RRA_1 > MRR$ determine the R.R. on the additional investment $FC_2 - FC_1$ by using the incremental benefits and costs. If the Incremental R.R. ($IRR(A_2 - A_1)$) thus calculated is such that $(IRR(A_2 - A_1)) \geq MRR$, the same procedure would be repeated for A_3 and A_2 . That is determine $IRR(A_3 - A_2)$ if $IRR(A_3 - A_2) \geq MRR$ select A_3 for implementation. If $IRR(A_3 - A_2) < MRR$ select A_2 for implementation. If at step 2 $IRR(A_2 - A_1) < MRR$ determine $IRR(A_3 - A_1)$. If $IRR(A_3 - A_1) \geq MRR$ select A_3 for implementation.

If $IRR(A_3 - A_1) < MRR$ select A_1 for implementation. This procedure may be represented graphically by

Figure 22.



A_1 in this situation may be continuing the present operations or the no action alternative.

4. Payback Period

The payback period is defined as the number of years it will take to recover the invested capital out of the net benefit cash flow. The number of years required for the payback is determined without considering the time value of money. Thus the payback period calculation would be to determine n such that

$$\sum_{k=1}^n (B_k - C_k) = C_0$$

As pointed out previously, the payback period as a measure of ranking alternatives has serious drawbacks. One is that no consideration is given to the time value of money. Another is that no consideration is given to benefit-cost streams after the initial payback period. The payback period is not usually appropriate as a decision criterion.

5. Capitalized Amount (C.A.)

Capitalized Amount is defined as the present worth of a uniform annual cash flow that continues for an infinite number of periods. This may be determined by

$$C.A. = \frac{A.W.}{i}$$

That is the C.A. is equal to the Annual Worth (A.W.) divided by the interest rate.

Capitalized Amount (Cost) is used as decision criteria for projects that have long lives - such as highways, dams, etc.

6. Benefit-Cost Ratio (B/C)

The B/C ratio is a dimensionless ratio of benefits to costs that may be determined from either the present worths of benefit and costs or the Annual Worths of benefits and costs - Using the P.W. notation the B/C is:

$$B/C = \frac{B_0 + \sum_{k=1}^N B_k \left(\frac{1}{1+r}\right)^k}{C_0 + \sum_{k=1}^N C_k \left(\frac{1}{1+r}\right)^k}$$

The B/C ratio has been used extensively in the justification of Governmental projects. It has the disadvantage of favoring projects with small first costs and minimizing the effects of Benefit-Cost streams occurring in the distant future.

Cost Considerations

In most managerial and engineering economics studies estimates and predictions of costs are restricted to project costs such as:

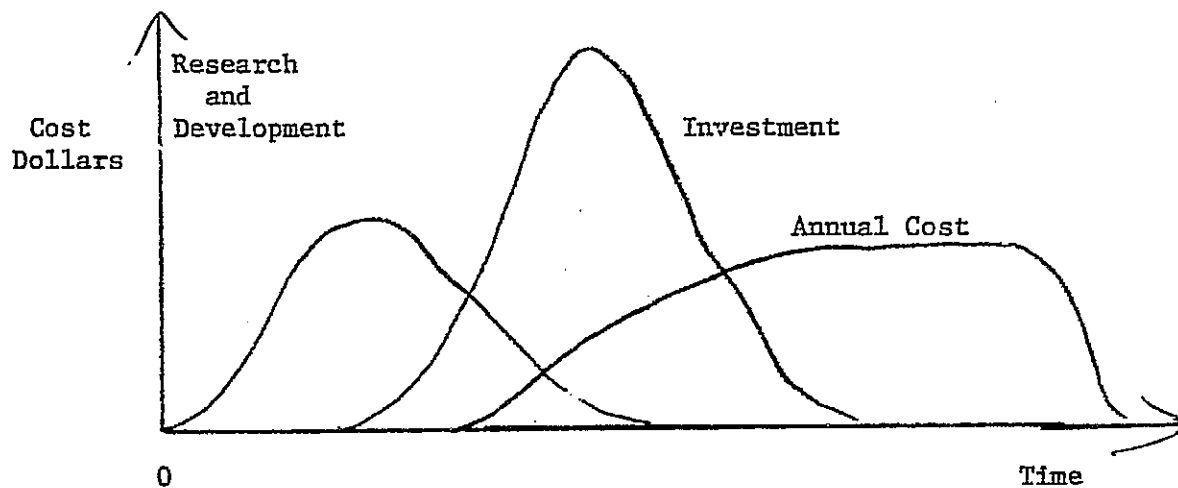
- Research and Development Costs
- Investment Costs
- Operating Costs
- Maintenance Costs
- Replacement Costs

In a framework of an extended economic analysis including a variety of interaction effects or "externalities" a number of other costs must be included. Among them are:

- Opportunity Costs
- Associated Costs
- Social Costs
- Alternative Costs

Costs here are estimated future costs so that in most situations, accounting cost are appropriate only to the extent that they reflect in some relevant way these future costs. The types and life cycles of various project cost are illustrated in Figure 23.

Figure 23.



Typically, Annual Costs include operating, maintenance, and replacement costs over the life of the project. At the end of the project there may be salvage values and phase-out costs.

Cost Estimating Relationship (CER) is a technique of estimating future project costs. The procedure is based on the assumption that costs are similar for projects that have similar characteristics. This allows one to develop mathematical relationships correlating specific costs and certain respective characteristics or parameters for a class of projects. This is done utilizing historic data. Estimated costs for a proposed project are then computed by inserting the appropriate parameters of the new project in the CER mathematical function that relates these parameters to the respective costs. CER estimations may turn out to be suitable for preliminary long-run forecasting. However, they are usually not precise enough for a detailed short-run forecasting. Upper and lower bounds of values and costs may be established in a manner similar to the PERT time calculations, where three estimates are obtained: pessimistic, a , optimistic, b , and most likely, m . In PERT calculations these estimates are assumed to be three values of a random variable from a Beta probability density function with mean and standard deviation determined by

$$\text{Expected Value} \quad \mu = (a + 4m + b)/6$$

$$\text{Variance} \quad \sigma^2 = [(b - a)/6]^2$$

In PERT analysis the means and variances thus estimated are then combined linearly depending on the PERT network relationships in order to achieve a total project expected value and standard deviation. With this approach the cost estimates are treated as mutually independent random variables. In practice, consideration must be given to independence or dependence of the cost components in order to justify this linear combination. If there exist dependences among the cost components then it

may be possible to use Monte Carlo simulation to arrive at the distribution of the Total Cost Random Variable. This is illustrated by the following schematic.

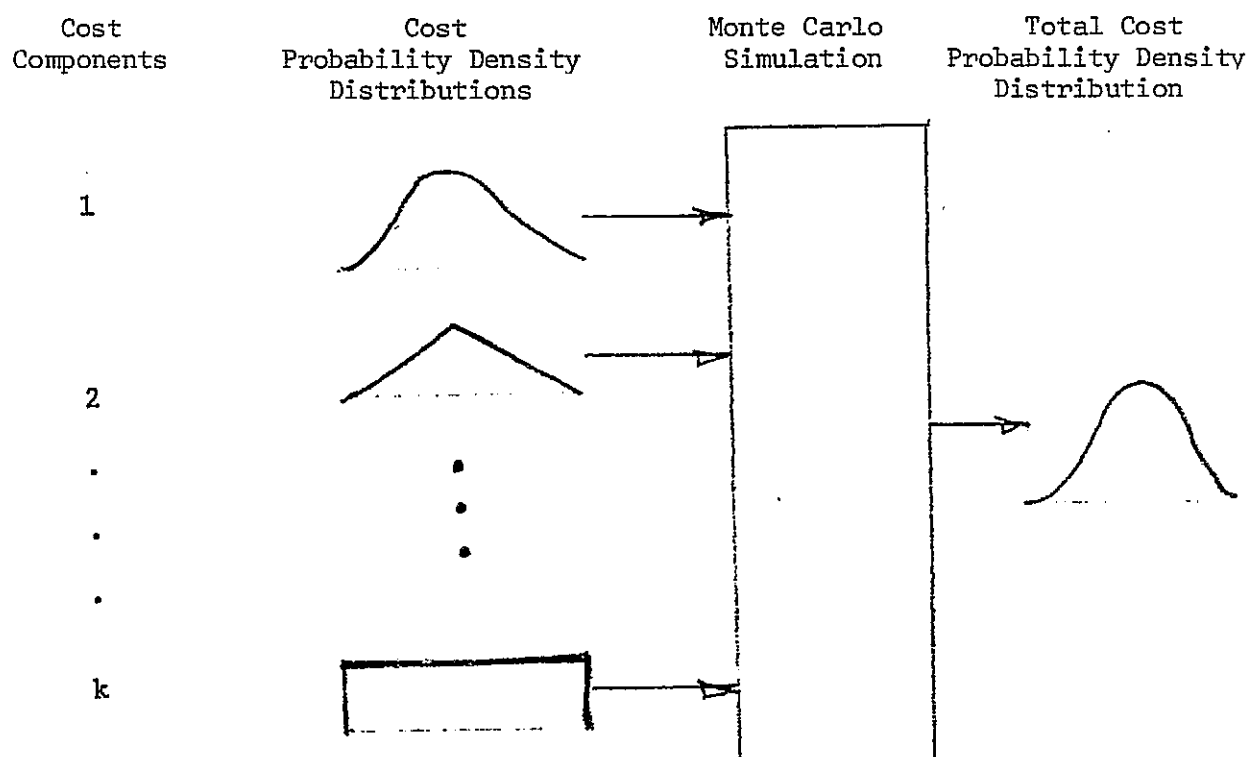


Figure 24.

Post audits of the relationships between estimated project costs and actual project costs tend to show that the estimated costs are less than the actual costs. Two possible factors contributing to such a bias may be inflationary effects and various administrative, logistics, etc., lags or delays not anticipated ahead of time. Various lag time distributions could be introduced into CER models. Inflationary effects could be treated, both, at an aggregated level as well as at a structural level.

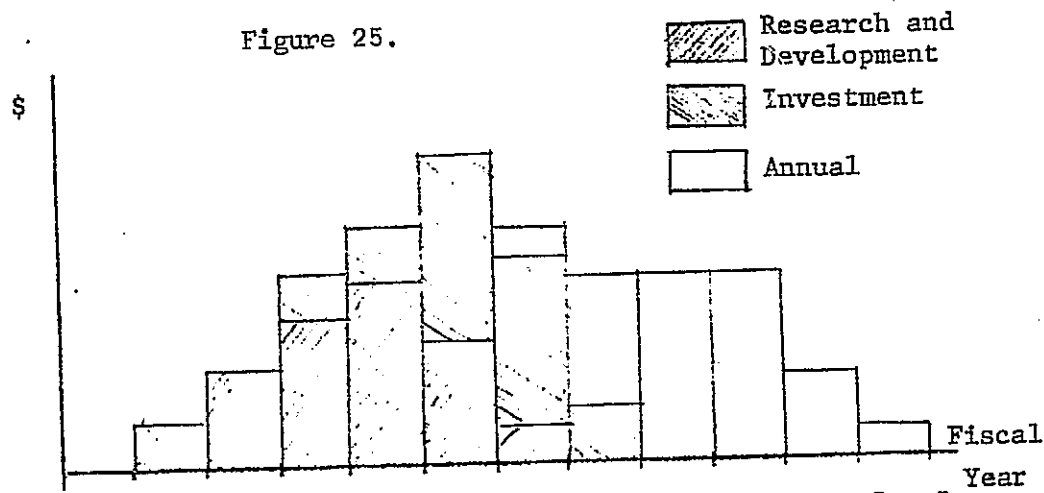
Some of these methods are as follows:

1. **Resource Analysis:** Resource Analysis considers the project costs in terms of the resources consumed rather than in monetary terms. This approach notes that monetary value of resources are inflated but not the resource units themselves. However, at some point in the analysis resource unit costs must be considered.
2. **"Then-Constant" Dollars:** "Then-constant" dollars refer to the actual dollars at the time the expenditure occurs. Inflationary effects can be included in this situation by adding an estimated

inflation rate, $i\%$, to a discount rate, $r\%$, to form an interest rate, $i\% + r\%$, to be used in the discounting process.

3. "Constant-Worth" Dollars: "Constant-worth" refers to a fixed lease year purchasing power in the dollars of that lease year. The effect of inflation is treated by converting the current dollars to the dollars of the lease year by utilizing the appropriate conversion factor called the implicit price deflator. Thereafter, $r\%$, is used in the discounting process.

In managerial accounting costs can be associated with research and development, investment in productive assets, and with operations.



The various cost groupings could be classified as follows [141]:

Research and Development Costs Arising from:

- Preliminary design and engineering
- Fabrication of test equipment
- Test operations
- Miscellaneous

Investment Costs associated with:

- Facilities
- Major equipment
- Initial inventories
- Initial training
- Miscellaneous

Operating Costs (Annual Costs)

- Equipment and facilities replacement
- Maintenance
- Personnel pay and allowances
- Replacement training
- Miscellaneous

Cost estimating relationships and cost estimates (detailed estimates) would be developed for each of these cost components.

The life cycle aspects of these costs are important. Research and development costs can be largely independent of the life cycle. Investment cost are closely related to the type and size of the project but are typically somewhat independent of the life cycle. Operating costs however are functions of the type and size of project as well as the life cycle.

The determination of the life cycle of a project is not obvious. There are some projects such as roads, bridges, and dams that have very long lives. In a technologically dynamic environment the operational life span of a project can be seriously affected by obsolescence. Many industries will not undertake an investment scheme if its payback period is greater than three years. This requirement may serve as a "safety factor" in dealing with uncertainty that increases the further one moves into the future. When the expectations of project obsolescence rates are high, the assumed life cycles are typically around 3 to 5 years. When the project obsolescence rates are expected to be small, then the operational life (economic life) of the project would determine the appropriate life cycle. The justification of large initial costs (research-development, investment) tends to become difficult for projects with short life cycles. There are important trade-offs between possible obsolescence rates, life cycle dynamics, and capital recovery.

In recent literature [148] the logic of the cost estimation appears as follows:

1. Subdivide a project into its subsystems or component parts down to the appropriate level of detail consistent with the available data base and the available time to do the job.
2. Further subdivide the subsystems or component parts into time phased implementation and procurement functions to be performed, such as research and development, investment, operations, and maintenance.
3. Then determine the total number of appropriate units required. This step may or may not be required depending on the nature of the project. However, some kind of evaluation of the size requirements of the project must be made.
4. Thereafter, estimate the system element costs. For this purpose an economic data base is required. An essential part of this economic data base is a set of "cost-estimating relationships" which are to be used to predict the future system costs based on past system costs of related systems.

The cost estimating and analysis should concentrate on the costs of the newer system elements for which one finds the highest degree of uncertainty. Further, it should concentrate on determining relative cost differences among alternatives rather than striving for highly accurate absolute values of costs.

Rudwick [148] illustrates the process of cost estimating by detailing the following sequence of interrelated events.

Step 1. Initialize the system.

- a) Determine operationally the job to be done.
- b) Develop system design model.

Step 2. Determine System size requirements. For given system capability and organization determine:

- a) Number of components required.
- b) Performance characteristic.
- c) System effectiveness

Step 3. Detail System requirements.

- a) Maintenance requirements; Equipment - Space Parts - Personnel.
- b) Operational requirements; Equipment - Inventories - Personnel.
- c) Additional Equipment requirements; RDT & E required to develop equipment.
- d) Other facility requirements.

Capital Recovery Costs (C.R.)

Capital recovery cost for a project is the equivalent uniform annual cost of the capital invested. In managerial and engineering economics studies this is used to account for the depreciation of an asset as well as the minimum attractive rate of return on the invested capital. As an example consider P to be the present worth of all the costs associated with research and development as well as investment. Let F be used to indicate the net salvage value of the asset at the end of its life cycle of N years. Let $r\%$ be the discount rate. Then C.R. is as follows:

$$C.R. = P(A/P, r\%, N) - F(A/F, r\%, N)$$

Two other relationships that may be used are

$$C.R. = (P-F)(A/F, r\%, N) - P(r)$$

or

$$C.R. = (P-F)(A/P, r\%, N) - F(r)$$

If one requires an after income tax analysis, the legally required method of depreciation must be used to determine the allowable depreci-

ation costs for each year of the assets life. The various individual methods of depreciation will not be discussed here.

Sunk Costs

When a proposed project is to make a use of assets that are already available and for which depreciation schedules have been established, it is possible that sunk costs might be present. The sunk cost is defined as the difference between the book value of the asset and its actual value. The book value of the asset is the difference between the first costs of the asset and the amount that has been depreciated according to the established depreciation schedule. The sunk cost (or the book value of the asset) should not be considered in the engineering cost analysis although it is very important in income tax analysis. For engineering accounting the true value of the asset is the real worth of the asset.

5. CONCLUDING REMARKS

The previous discussion on managerial and engineering economics was intended to provide an overview of the basic traditional methods of project evaluation and decision criteria that also apply to benefit-cost analysis. It was not intended to be all-inclusive of many of the topics found today in this area of discipline. For example, no specific discussion was done on depreciation accounting, income tax and after tax analysis, replacement and reliability analysis, maintainability and logistics analysis, capital budgeting, and a variety of modern methods of program evaluation. The areas of risk and uncertainty analysis can be expanded greatly, and the techniques of simulation could be treated extensively. However, it is hoped that the above discussion provided a bridge to a better understanding of the powers and limits of benefit-cost analysis to be discussed subsequently.

V. MARKETING ORIENTED BENEFIT-COST ANALYSIS

1. THE MARKETING CONCEPT

Within the spirit of the traditional microeconomic theory the outputs of a business firm are goods and services sold in a marketplace. The goals of a firm are to earn a profit, to acquire and maintain an adequate market share to assure specific volumes for its outputs, and to be able to survive and grow, these goals being not mutually exclusive. The marketing activities of a firm are essential for these goals. Especially since the World War II the affluent society has been characterized as a "marketing limited economy" in a distinction of the "production limited economies" of the third world. In the developed world marketing has become the basic and conscious force for the fulfillment of Say's Law: Production creates its own demand and vice versa.

In a "marketing limited economy" customer orientation in conjunction with the business goals of survival and growth, maintenance of adequate market shares of its products, and the profitabilities of these products form the foundation of the marketing concepts. In particular, among other criteria, a business firm must consider the benefits and costs of its marketing activities in terms of the return on the assets employed. This is necessary from the point of view of accounting and controlling the benefits to the firm against the costs to the firm in the best possible direction among the alternative ways of employing the assets.

It also suggests that in order to achieve maximum long run return on the assets employed the firm must understand the effect of its activities on the benefits and costs which the consumer desires and incurs, respectively, from the acquisition and use of the products generated by the firm. In effect, the firm not only must understand the financial implications of its own activities. It must also understand what benefits and costs the consumer perceives will be available and incurred, respectively for the consumer by the firm's activities. The firm must probe the minds of the consumers and understand how these consumers perceive the activities of the firm.

Furthermore, the firm must understand the benefits and costs which society perceives, and how these benefits and costs are affected by the firm's activities. The firm must probe the mind of the consumer collective known as the society and understand how this society perceives the activities of the firm.

In the same way that the benefit/cost ratio determines the firm's behavior, (above a predetermined positive value, go; below that value, no go), it is assumed that a consumer's benefit/cost ratio determines the consumer's behavior toward the firm (above a predetermined positive value, advocate; below that value, indifferent or adversary).

The marketing approach focuses on the customer, not the company or the product. Everything is based upon a philosophy of customer orientation. It is the customer on whom the firm focuses. The profit earned flows from the fact that the business is run from the point of view of the market and the customer [149, p. 27].

The marketing concept is a business philosophy stating that the customer's want satisfaction is the economic and social justification of the existence of a firm. All company activities such as production, engineering, and finance, as well as in marketing, are to be devoted first to the determination of the customer's wants and then to satisfying these wants while still making a reasonable profit [150, p. 9]. The contemporary "marketing revolution" assumes the rapidly expanding freedom of consumer choice among alternative goods and services and among alternative producers of any chosen good or service [151, p. 2].

The issue lies in the assumption that freedom of consumer choice however, is relative rather than absolute. The single most important determinant of the "freedom of choice" is the affluence of consumers and the society in question. In a production limited subsistence society consumer choice is minimal. When the production capability of an economy is poorly developed, this society is not able to meet the barest needs of its consumers. Consumers have to take whatever they can get. Today's Third World is still largely in this state. The productive capacity of the developed nations this time exceeds the minimal level necessary to satisfy the basic needs of the consumers. At the same time, the per capita income of the bulk of consumers in the developed world is such that consumers have more than adequate income to buy the products and services needed to satisfy their basic needs [151, pp. 1-2].

2. THE IMPLEMENTATION OF THE MARKETING CONCEPT

From the point of view of a firm its benefit-cost analysis refers to understanding what effect a particular marketing strategy will have on the firm's revenue minus cost flows. While business power clearly relates to the sales volume and the respective market shares for its outputs, the adoption of the marketing concept with its philosophy of customer-orientation stresses the implementation of this philosophy with optimization of profit, rather than sales volume.

Presumably there is no interest in sales volume for volume's sake. Management in an operational environment is interested in results which it can measure in terms of profit, and, particularly, in terms of return on investment (assets employed). This is basically an immediate and short-run view. Management likes to measure the performance of the marketing function and marketing managers by financial results. Executives in marketing are viewed as "managers of money" as well as "marketers of goods and services". As managers of money they need to deal with such financial concepts as return on investment and break-even analysis, as well as the related concept of contribution margin, and

the applicability of these concepts to such areas as sales territory performance, sales force expansion, pricing strategy, the customer mix, the product mix, and related variables, all of which affect profit achievement [152, pp. 35-37].

3. RETURN ON INVESTMENT (ROI)

Return on investment is used increasingly by companies with a sophisticated approach to financial management of their operations. These companies feel that the relative productivity of assets employed in particular activities or projects is a better measure to use than profits measured as a percentage of sales volume. Return on investment, or ROI is considered preferable, both as a guide in making business decisions and as a yardstick for evaluating performance especially in an operational environment.

Return on investment is a function of the percentage of profit on sales and the turnover of assets employed, i.e., the rate at which an invested dollar is generating sales dollars, as shown below:

$$\begin{array}{l} \text{Basic} \\ \text{Formula:} \end{array} \quad \frac{\$ \text{ Net Profit}}{\$ \text{ Sales}} \quad \times \quad \frac{\$ \text{ Sales}}{\$ \text{ Investment}} \quad = \quad \frac{\$ \text{ Net Profit}}{\$ \text{ Investment}} \quad \text{(assets employed)}$$

$$\text{Or:} \quad (\text{Rate of Profit}) \quad \times \quad (\text{Turnover}) \quad \quad (\text{ROI})$$

The rate of profit is affected by the volume of sales which is a function of price, product mix, factory costs, as well as marketing and administrative expenses. The turnover component relates investment to sales and is independent of costs or profit. This turnover is the rate of utilization of the assets such as plant and equipment, inventories, receivables, and cash [152].

The Merchandising Efficiency Index, is a special case of return on investment. It is a variant that is of interest to retailers and those selling to retailers. A retail merchant usually can do little in short run to influence the size of his "fixed" investment, i.e., his store, fixtures, etc. But he can vary his merchandise inventory investment in short run, in response to changing patterns of customer demand. His essential desire is to achieve an optimum turnover (velocity of movement) of his stock in relation to demand with an optimum rate of profit on his sales dollars. The interaction of these two factors will determine the rate of return on his inventory investment. The Merchandising Efficiency Index is defined as follows:

$$\frac{\$ \text{ Profit}}{\$ \text{ Sales}} \quad \times \quad \frac{\$ \text{ Sales}}{\$ \text{ Inventory (cost)}} \quad = \quad \frac{\$ \text{ Profit}}{\$ \text{ Inventory}} \quad = \quad \text{ROI}$$

$$(\text{Profit rate}) \times (\text{Inventory Turnover}) = \text{Return on Inventory Investment}$$

The principle of using a special form of ROI index as a basis for comparing relative performance can be extended to contrast different types of retail institutions. In comparing a traditional department store to its new low-margin rivals, as represented by the so-called discount house and the supermarket, the ROI index is modified so that the profit rate is a gross margin. This margin is the spread between cost of goods and selling price. The turnover figure represents rate of stock. In this case the ROI formula is as follows:

$$\frac{\text{Gross Margin}}{\%} \times \text{Turnover} = \text{ROI Index}$$

The resulting ROI indices are useful because they reflect the differences in basic operating philosophies between conventional department stores and low-margin retailers. Typically, department stores, characterized by relatively high gross margins and relatively slow merchandise turnovers, show a lower ROI index. In contrast, the higher ROI index of low margin retailers is a product of lower gross margins and much faster turnovers. By gearing their operations to high volume and high velocity, they can afford low margins with increased volume throughput of goods. This produces a lower fixed to variable expense ratio as volume expands. The comparative ROI indices point out the impacts of operating philosophies between different types of retail institutions.

The way a retailer and/or manufacturer invests in a brand and takes risk in it is illustrated in Figure 26 covering the Processing and Packaging, Distributive, and Retailing Subsystems. This brand by brand investment-risk impact matrix can indicate specific costs or investments per unit of each brand identifying thus how ROI is affected by each component of each subsystem in the overall business system. Such an item by item analysis provides information for the profitability analysis of the retailing businessmen in a detail necessary for a clearly identified managerial control.

4. BREAK EVEN ANALYSIS

Break-even analysis deals with volume-cost-profit relationships, and helps one to anticipate the results of certain kinds of decisions before they are made. It can be a very useful management tool in the decision-making processes.

The first step is to classify all costs into two types: variable and fixed. It is important to distinguish clearly between these two types of costs. Variable costs vary as sales vary. Examples of variable costs include: cost of goods sold, sales commissions, freight, delivery, packaging, etc. Fixed costs, on the other hand, remain constant as sales volume varies. As sales go up, the percentage of fixed costs drops. Conversely, as volume falls off, the percentage rises. Fixed costs includes occupancy costs, certain utilities, insurance, executive salaries, and so on.

An Illustration of a ROI Control Matrix for A Retailer R versus Manufacturer M

Goods	Processing & Packaging System Investment					Distributive Investment			Retailing Investment			Total Investment Per Unit	Retailer's Investment Per Unit
	Land	Plant	Machinery	Warehouse	Inventory	Warehouse	Trucks	Inventory	Store	Fixtures	Inventory		
Brand A	M	M	M	M	M	M	M	M	R	R	R		
Brand B	M	M	M	M	M	M	M	R	R	R	R		
Brand C	M	M	M	M	M	M	R	R	R	R	R		
Brand D	M	M	M	R	R	R	R	R	R	R	R		
Brand E	R	R	R	R	R	R	R	R	R	R	R		

R in the matrix represents retailer's risk and investment for the brand indicated in the system.

M in the matrix represents manufacturer's risk and investment for the brand indicated in the system.

Figure 26.

The general setting of a break even analysis for a particular product or brand Q produced in a quantity of q units is as follows:

1. Identify all mutually exclusive costs C_i allocated to the product or brand Q produced in a quantity of q units, $i = 1, 2, \dots, n$.
2. Each and all costs C_i must be either identified as and/or split into a variable cost component $VC_i(q)$, which varies with varying q, or a mutually exclusive fixed cost component FC_i which does not vary with q.
3. The total variable cost associated with Q is then

$$VC = \sum_i VC_i(q)$$

and the total fixed cost associated with Q is

$$FC = \sum_i FC_i, \quad i = 1, 2, \dots, n.$$

4. The total cost associated with the product or brand Q is then

$$TC = VC + FC$$

5. Let p be the unit price of the product or brand Q sold in a marketplace. Then sales revenue is

$$R = pq$$

6. Profit from the product or brand Q is then

$$P = R - TC$$

Figure 27 illustrates this situation. If q is below the break even quantity q_e the product or brand Q is unprofitable resulting in a loss while above this quantity q_e the volume q would generate profits.

Typically, the accounting rate of return or ROI and the Break Even Analysis are based on traditional microeconomic analysis for short-run operational planning and control. Further, the approach is marginal in nature. The change in profit is

$$\delta P = p\delta q + q\delta p - \delta VC(q)$$

Where the first term in the right hand side is due to a change in sales volume q, the second term is due to change in unit price of the product or brand Q, and the third term is due to changes in the variable cost of producing the product or brand Q with a volume q. The break even analysis is conducted first in order to find the minimum required sales volume for a non-negative profit, thereafter ROI is used to evaluate the profitability impact of various alternatives.

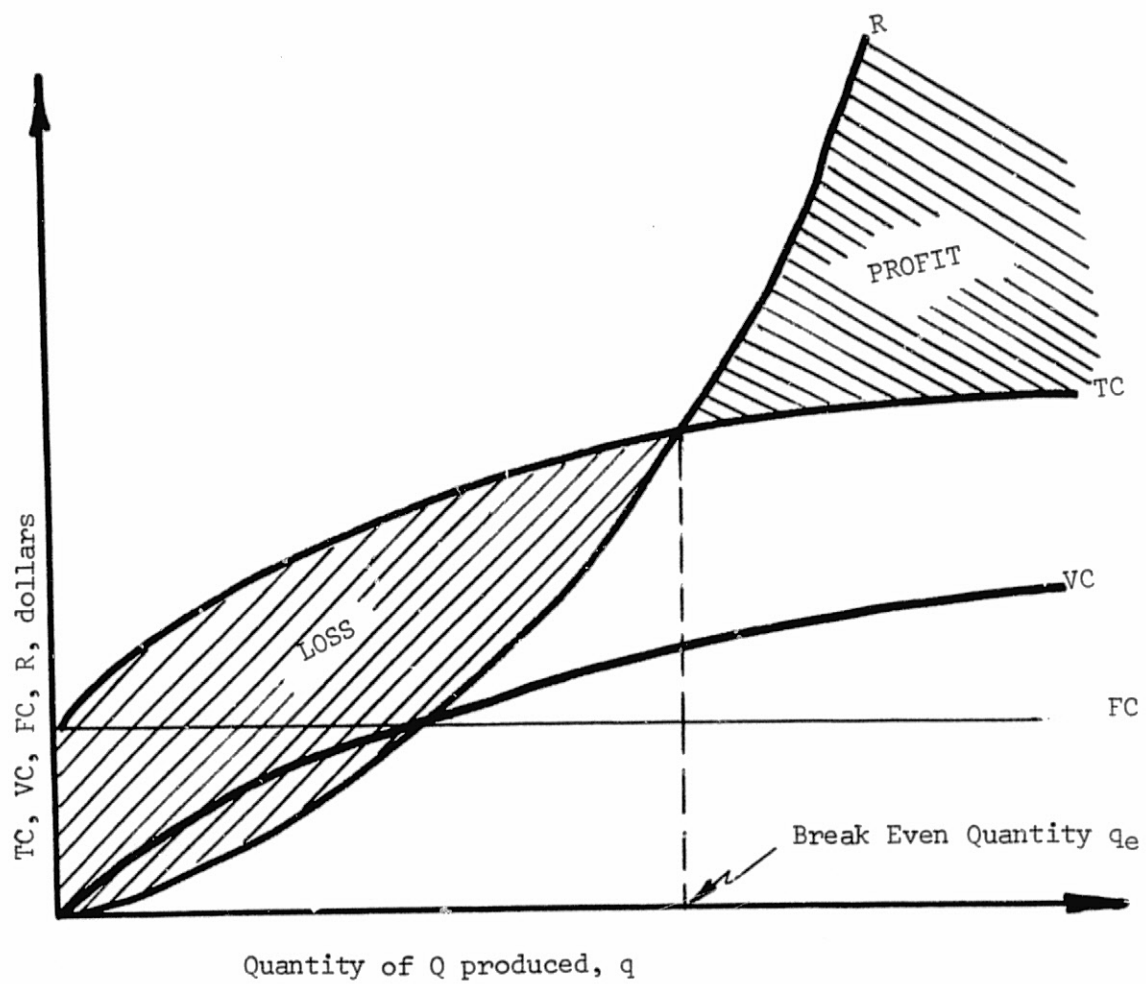


Figure 27.

The techniques of break-even analysis and return on investment are profitably employed in marketing planning and control, for example, in the following cases:

1. the volume-cost-profit relationship;
2. sales force expansion;
3. sales territory ROI analysis;
4. the channel of distribution (customer) mix;
5. pricing;
6. the product mix: adding a new product; (and)
7. the product mix: shifting promotional emphasis

5. LONG RUN MARKETING CONSIDERATIONS: PRICING AND PRODUCT LIFE CYCLES

In the long run everything is variable. In particular, all costs are variable costs. Typically, it is to be expected that for a particular product its volume demanded in the market is a function of its price as well as a function of the prices and quantities of all other products. In the long run, each product must be viewed in the framework of the total business system. It also has to be viewed in a dynamic setting where a product is innovated into existence and renovated for its survival against forces of its mortality due to technological obsolescence, competing products, changing tastes of consumers and changing needs of social institutions. In such a setting the short run consideration based on the traditional microeconomic theory can be expected to be inadequate for the evaluation of alternatives facing a firm.

Figure 28 illustrates a typical sales volume life cycle and its respective profit margins life cycle [152, p. 62]. Its impact on marketing and business planning is well recognized [153,154,155]. Appendix G provides an illustration on how to analyze a particular product life cycle utilizing the concept of forces of innovation and renovation in an interaction with forces of product mortality.

The typical distribution of costs in successful product innovations can be plotted on the basic life cycle curve as costs incurred prior to the introduction of the innovation. The marketer treats these costs as an investment in the new product. It is the costs incurred after the product is introduced that are either variable or fixed, not those incurred prior to the product's introduction. The fixed cost is assumed to occur after the product has been introduced. If the new product is successful, its net benefit-cost stream is assumed to provide a return on the investment which was defined as the costs incurred prior to the introduction of this product.

The cost of introducing a successful innovation, representing the investment in this innovation, can be broken into the following "typical" percentage components [156, p. 9]:

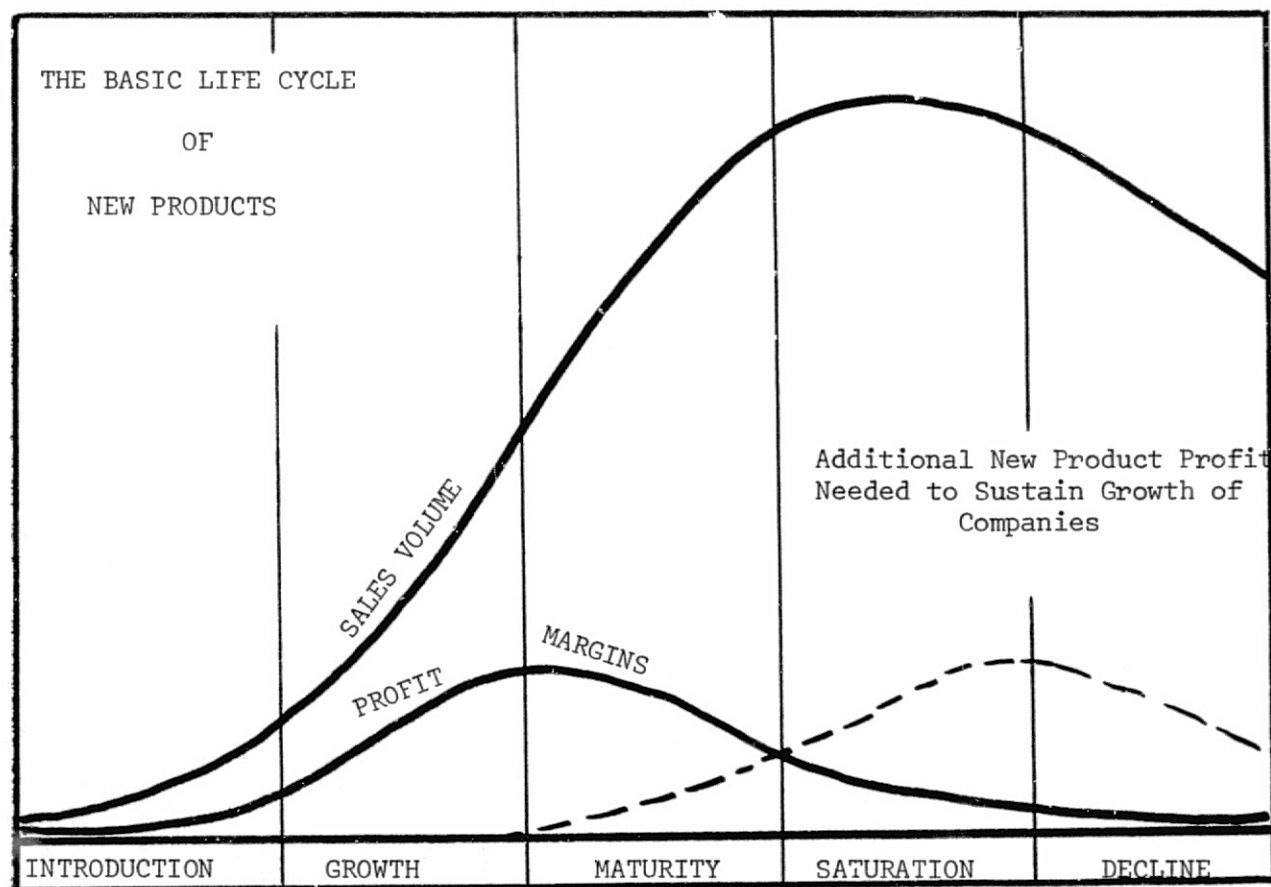


Figure 28.

Cost Item	Percentage of Total Investment
R&D, Basic Invention	5 - 10 %
Engineering & Product Design	10 - 20 %
Tooling Up and Getting Ready for Manufacturing (e.g. investment in a plant)	40 - 60 %
Manufacturing Start-Up Expenses	5 - 15 %
Marketing Start-Up Expenses	10 - 25 %

6. MARKETING CONCEPTS VERSUS CONSUMERS' (USERS') BENEFITS AND COSTS

Ultimately the use value and fitness for use of a product or a service is perceived by the consumer of this product or service. While a firm is interested in a marketing approach that provides it benefits minus costs as measured, for example, by ROI, it obviously cannot ignore the impacts of its products on the consumers' wants. A product affects consumers' immediate wants and satisfaction derived from this product. But the production and consumption of a product have induced effects such as generation of air pollution, solid waste, health hazards, and so on. It has been suggested that concept of a consumer-citizen would provide the two perspectives; consumer in regards to the use and satisfaction derived from a particular product and a citizen concerned with the induced effects of the product upon the ecological environment of human beings [151, p. 3].

Marketing planning is concerned with the conflicts between its prime preoccupation of satisfying consumers' individual needs on one hand and the social responsibilities of firms for the preservation and betterment of the ecological environment on the other hand. In a setting of such a conflict, markets will be evaluated in terms of the consumer-citizen duality where individuals are thought to be not only concerned with their immediate self-centered satisfactions but also with an overall societal well-being. It is, indeed, possible to consider a market segmentation approach where both societal and individual benefits become important stimuli for responses [157, pp. 61-65]. Such an approach could be conceived in terms of a social preference function that includes, also, individual preferences, rather than on the basis of the classical preference theory of the individual consumer behavior. In fact, the concept of a consumer-citizen is a step in this direction. It could be interpreted to be a "behavioral model" where an individual behavior can be strongly affected by "externalities" including those affecting the overall social welfare; or, better yet, in a contrast to the traditional microeconomic theory an "individual" is also a "collective societal homo sapience".

As a consequence of these kinds of modifications, marketing seems to be increasingly concerned with societal aspects of the direct and indirect impacts of consumption and its respective production especially on basically limited natural resources [158]. The Western Society has had its exploitive characteristics based on an assumption that for all practical purposes natural resources are limitless. To this notion has been superimposed that of the consumers' "freedom of choice" and limitless pursuit of happiness. The business philosophy has rested, on one hand, heavily on the eighteenth century economic liberalism and its formalized gospel, the traditional atomistic microeconomic theory. On the other hand, it also has been resting over the last few decades on the Neo-Keynesian macroeconomic theory that emphasizes consumption as the measure of societal and individual welfare. Both of these theories are short-run equilibrium theories in a setting of a partial analysis. Neither one provides an adequate overall system view for the accounting of long run consequences of production and consumption patterns eating away in an irreversible manner certain basically limited natural resources. The whole setting is accentuated by the pattern of a faster than exponential growth of the world population.

7. SOCIAL DIMENSIONS OF PRIVATE SECTOR BENEFIT-COST CONSIDERATIONS

It is recognized now that the private sector firms may not be in a position to provide appropriate planning-decision processes with regards to social benefit-cost considerations. They cannot judge effectively the net effects of the inclusion of social benefit-cost criteria in their marketing planning-decision processes; and if one firm decides to include social benefit-cost criteria in its marketing considerations, it might be placed at a competitive disadvantage. Therefore, the role of the public sector must be assumed in order to complement the shortcomings and eliminate the inabilities of the private sector in adequately including the social benefit-cost criteria into the general business planning-decision processes in a total societal framework [158].

In a sense, then, the concept of marketing must be expanded from its traditional framework at a level of an individual firm to a societal setting with some distinct public policy implications. Among these are various possible taxation and transfer-payment policies, "environmental audit" of corporate performance, and so on, in order to compensate for or prevent adverse social costs of the private sector activities. Among the suggested social and environmental factors for the evaluation of new products are [159, p. 13]:

1. Environmental and production compatibility.
2. Environmental and user (consumer) compatibility while product is in use.

3. Environmental and user (consumer) capability after the product is used up or consumed.
4. Recycling potential.
5. Social and moral impacts.

Some marketing experts think that societal dimensions of benefits and costs can be incorporated better into the "total marketing" efforts if the emphasis is shifted from physical products into services that encompass also the necessary factors directly benefiting the society [158, p. 59]. It has been suggested that firms need an increasingly "total systems approach" to marketing in order to include the societal benefit-cost perspectives - a concept of "Social Marketing" [160].

8. CONCLUDING REMARKS

In a relatively "microeconomic" environment, private sector firms have been very successful in developing effective marketing concepts. There remains considerable room of such efforts for institutions in the public sector. The desirability of developing the public sector marketing efforts relates, among other things, to the identification and assessment of the benefits and costs of public projects in complex economic, social and political environments with a variety of structural perspectives. An example would be the assessment of a new major technology with its potential for a multitude of economic, social and political impacts which may not be detectable early enough through the channels of the usual political processes. A detailed "market survey" for public acceptance may turn out to be a useful detector of the present and future moods of a populace.

VI. TRADITIONAL PUBLIC SECTOR BENEFIT-COST ANALYSIS

1. INTRODUCTION

In a distinction to the "private" goods and services purchased and consumed unequally by the consumers, public goods are collective goods enjoyed in common by all the members of a society. Public goods can be divided into intermediate and final goods, and public investment could be thought to be associated with public product life cycles. If it was possible to assess all benefits and costs or sacrifices associated with such a product life cycle, then the usual techniques used in managerial, engineering and business economics could be used to provide decision criteria for the selection of a best alternative public program from a set of possible alternatives. In a methodological sense, public sector benefit-cost analysis is an extension of the traditional private sector economic analysis in a setting which includes not only the private sector economics but also the welfare economics. From a systems point of view, both the private sector and public sector economic analysis should be done in the framework of the total societal economic, social and political system. Traditionally, this is not quite the case. For example, the benefit-cost analysis tends to be done typically in a setting of a partial analysis utilizing short-run static equilibrium models of microeconomics. It tends to be preoccupied with direct costs and benefits as such economic models exclude by their very nature the ability to account for a variety of "externalities" whose characteristics need to be understood for the imputation of "induced" or "secondary" or "indirect" benefits and costs. Yet in a dynamic setting of an economic development these induced, secondary or indirect effects may far outweigh the immediate short-run or static direct effects in generating an impact of a net benefit or detriment upon the society by a public project.

The first task in a benefit-cost analysis is the identification and definition of benefits and costs associated with a proposed public project over its life or life cycle. In this task a serious problem arises immediately in that benefits and costs relate to the very economic model assumed for the background of the analysis. Is this economic model relevant? Does it portray and predict the actual behavior of the society? Is it only an ill-constructed normative model far away from the realities of life? Is it a reflection of a value system of a politician or a theoretician or that of a society? These kinds of questions are obviously important at a policy and strategic levels. In practice benefit-cost analysis belongs to strategic and operational levels of planning-decision processes. At such levels the policy guidelines including the economic model to be used as a background for the analysis may have been specified. Therefore, the analyst's problem is reduced to the proper identification and definition of benefits and costs in a framework of a given and specified economic model and theory. In a traditional setting this theory is derived from the Walras-Pareto general equilibrium model and its various modifications to account for "imperfections" and "externalities" seemingly occurring in "real life".

2. A HISTORIC SKETCH OF BENEFIT-COST ANALYSIS

The roots of the evolution of the philosophy of benefit-cost analysis lie in the history and progress of welfare economics. Among others, Adam Smith was concerned with welfare economics, public finance and principles of taxation, and how these affected consumers' benefits and sacrifices. The eighteenth century emergence of economic liberalism profoundly influenced the way benefits and sacrifices were to be defined and related to the theory of consumer behavior. While economic liberalism was a reaction to the rigid centralized mercantilistic policies, and favored individual freedom of choice and individual enterprise as the foundations of value theory, the emerging industrial revolution brought back into the picture the necessities of social control of business. The role of the public sector became not only that of a protector of the private sector and its liberal "rights" but a controller and performer in the direction of the overall welfare of the society, augmenting the shortcomings of the private sector and keeping its imperfections from hurting the society as a whole.

As the industrial societies grew increasingly interdependent, the public sector was recognized as a provider of public goods and services necessary for a coherent overall societal operation. Public programs became justified by their ability to produce those essential ingredients for the society that private sector did not care or could not produce or was not allowed to produce because of the concomitant monopolistic implications. Thus public programs were supposedly designed to generate "external economies" or "social benefits" as well as to keep down "external diseconomies" or "social costs" reflected throughout the private and public sectors of economy.

In 1844 Jules Dupuit published his "On the Measurement of the Utility of Public Works". Dupuit introduced a measure of net welfare gain from a public project: the consumer surplus. This concept was later refined by Marshall, Hotelling and Hicks. However, it was not until 1950 that the concept of consumer surplus emerges again as a key concept in the analysis of public investments and projects. During this era from Dupuit to 1950 Federal projects in United States were largely justified in terms of direct tangible costs and benefits. For example, the 1902 U. S. River and Harbors Act called for project justifications in terms of direct benefits to commerce versus the direct costs of the respective projects. The U. S. Flood Control Act of 1936 stated that a project is "...feasible if the benefits, to whomsoever they may accrue, are in excess of the estimated costs." The precise interpretation of the meaning of "benefits" was left to the discretion of a particular agency of the U. S. Government. It was not until 1950 when the Inter-Agency Committee on Water Resources published its "Proposed Practices for Economic Analysis of the River Basin Projects". This publication, known as the "Green Book", introduces the language of welfare economics to the practice of public project evaluation, analysis and justification.

The Department of Budget Circular A-47 followed in 1952. Both publications discussed social gains in terms of maximizing the gains to the national product without regard to social gains and losses that cannot be expressed in terms of the National product. The result was that the objective of Benefit-Cost Analysis was that of economic efficiency.

With the publications of Eckstein, McKean and Krutilla in 1958 and Maass in 1962 the theory of Benefit-Cost Analysis became definitely integrated with the welfare economics, and benefit-cost analysis began to assume a nature of multi-objectives, at least in the areas of water resource development. The multi-objective benefit-cost analysis introduced complications not encountered with considerations for single objective-economic efficiency. That is all of the objectives are not necessarily quantifiable in terms of common measures. In a setting of multiple objectives some trade-offs must be developed between the benefits and costs associated with each of the different objectives.

In 1961 Planning-Programming-Budgeting (PPB) was introduced in the Department of Defense and by 1968 had spread to the entire Federal Government. One of the features of PPB was the quantitative evaluation of alternatives by benefit-cost or by cost-effectiveness analysis. By 1968 most Federal Governmental Agencies and some state governments were performing their own benefit-cost analysis for their project justifications. The spread was from water resource projects to transportation projects, defense projects, income maintenance programs retraining programs, proposed research and development projects, health programs, recreational facilities, public utility projects and law enforcement. The bibliography provided with this report contains references of publications in each of these fields. Henrichs and Taylor (1969) categorizes their bibliography into Background Material; General; Community Development and Services; Health, Education and Welfare; Highways; National Defense; Research and Development; Resource Development and Transportation.

The applications of benefit-cost analysis are still expanding into new fields. There are many unsettled problems challenging the analyst. The difficulties of benefit-cost analysis are divided by Hender in Institute of Municipal Treasures and Accountants (1971) "...into two broad groups -- technical difficulties of using the technique and difficulties in its practical application". These groups are not mutually exclusive. The listing of the difficulties may be associated with one or the other or both groups.

It should be again noted that the Planning Programming Budgeting System was retired as a practice in Federal Government around 1970; and that there are several serious questions concerning the nature of benefits and costs in modern highly interdependent economies in which economies are not necessarily portrayed very well by various conventional economic theories. One of the most serious questions relates to the desirable nature of income distribution versus such conventional notions as Pareto optimality; and another question relates to the theory of state and the respective role of public sector versus private sector.

3. THE STATE-OF-THE-ART OF BENEFIT-COST ANALYSIS AND EXAMPLE

The basic idea of benefit-cost analysis is to determine the worth of a public project by weighing the advantages and disadvantages of such a project to the society as a whole. It would be desirable that the advantages and disadvantages of the project be evaluated in terms of some overall social gains and losses. That is the economic, social, political and environmental impacts of a project should be determined as well as the technological and economic feasibility. Cost-benefit analysis attempts to be a way of deciding what society prefers. If only one option can be chosen from a set of options, benefit-cost analysis should help the decision-maker to select the socially most preferred option. Benefit-Cost Analysis is a part of the decision-making process. It helps the decision-maker in his evaluation of the relative merits of public projects in terms of their various economic, social, political, environmental, technological, etc., feasibility.

The practice of benefit-cost analysis has considered mainly the aspects of economic and technological feasibility. Whenever the social, political or environmental impacts have been considered no adequate method of presentation of the information to the decision-maker has resulted. To treat benefit-cost analysis as an arithmetic exercise from which a single numerical value is obtained is at best narrow if not unrealistic. In practice, benefit-cost analysis is often used to substantiate prior decisions or to support a previously selected decision outcome. When the analysis is used in this manner biases may be introduced and mishandling of benefits, cost, intangibles, discount-rates etc. can occur.

Another problem and source of abuse associated with benefit-cost analysis is the establishment of a suitable basis of measurement so that a comparable ranking with other projects may be obtained. It is important to realize that not all gains and losses associated with a project can be measured in terms that clearly indicate their relative values in relation to identifiable societal preferences. In such cases the decision-maker must decide what weights to apply to these kinds of measures. Typically, the decision-maker has an objective function which he is trying to maximize or minimize or perhaps he has a multiple objective function which he is trying to optimize thru some weighing or trade-off procedure.

The extent that individuals or groups of individuals are used in assessing the preferences of a society is a fundamental problem of benefit cost analysis. In a decision-making-process how are individual and group preferences related? Further, what a society prefers is not necessarily always in the long run best for the society. Should the decision-making-process concerning public investments be accomplished by politicians with their vested interest approach? What weighing procedure should be used for the various groupings on individuals of society? Should a unit of benefit or cost be valued the same for one individual as for another one? What time period should be considered for the analysis? What discount-rate? What should be the point of view of the benefit-cost analyst, or the decision-maker?

Let us consider an example presented in the literature that show some of the approaches that are being considered to solve some of the before mentioned problems.

Example

This example is taken from the work C. H. Oglesby, B. Bishop and G. E. Willebe - "A Method for Decisions Among Freeway Location Alternatives Based on User and Community Consequences" published in Highway Research Record - "Socioeconomic Considerations in Transportation Planning". [341] The quotations and tables that follow are taken from this publication with the consent of the authors.

"To carry out an engineering, economic, and social analysis of the effects of freeway location requires that a basis be established for evaluating both user and community consequences when comprehensive comparisons are made of the differences among alternatives. To accomplish this requires that 3 important aspects of the problem be considered: (a) quantification and separation of user and community factors, (b) viewpoint decision makers, and (c) time period of analysis. Decision-makers should include all of these in their analysis if optimal decisions are to be made."

In this article two principles of decision-making are recognized: (1) Decisions are to be based on the differences between the alternatives, and (2) Monetary aspects must be separated from aspects that are not quantifiable in monetary terms, and that the non-monetary terms must then be weighted against the monetary aspects by the decision-maker. The success of the decision-making-process depends on the analyst's ability to define and measure the factors that measure the relative merits of the alternatives. To achieve this the authors divided the consequences of a project into direct and indirect effects. These are presented in Table 1 and 2. Table 1 shows the direct effects that are associated with highway construction and use, while Table 2 gives an indication of the indirect effects that are associated with the non-user and community. These tables as presented in the above reference are given below.

TABLE 1
DIRECT EFFECTS OF FREEWAY CONSTRUCTION AND USE

Factor	Description	Units	Time Period, Years
Quantifiable market values			
1. Cost of highway			
a. Planning	Capital cost and annual cost of planning, constructing, maintaining, and operating the freeway	Dollars	N. A.
b. Right-of-way		Dollars	20 to 40
c. Construction		Dollars	20
d. Maintenance		Dollars	Annual
e. Operation		Dollars	Annual
2. Costs (benefits) to highway user			
a. Vehicle operating cost, including congestion costs	Net increase (decrease) in costs of vehicle operation per year	Dollars	Annual
b. Travel time savings, commercial	Net increase (decrease) in travel time multiplied by dollar value of commercial travel time	Dollars	Annual
c. Motorist safety, economic cost of accidents	Net change in expected number of accidents multiplied by average cost per accident	Dollars	Annual
Quantifiable nonmarket values			
3. Costs (benefits) to highway user			
Travel time savings, noncommercial	Minutes saved per vehicle trip	Minutes or hours	Annual
Nonquantifiable nonmarket values			
4. Costs (benefits) to highway user			
a. Motorist safety	Accident costs of pain, suffering, and deprivation	?	Annual
b. Motorist comfort and convenience	Discomfort, inconvenience, and strain of driving	?	Annual
c. Aesthetics from driver viewpoint	Benefit of pleasing views and scenery from the road	?	Annual

TABLE 2
COMMUNITY EFFECTS OF FREEWAY LOCATION AND USE

Factor	Measures and Suggested Measures		Time Period	
	Description	Units	Long Run	Short Run
Local Transportation Effects				
Traffic service to community by freeway-highway capacity, O-D of trips, major traffic generators	1. Percent reduction of through traffic on city streets [(vehicles before - vehicles after)/vehicles before]	Percent	x	
	2. Distance of freeway access from major traffic generators (e. g., academic, business, cultural, administrative centers) or as measured by road user or transportation costs	Miles	x	
	3. Corridor miles compatible with present or future public transportation development	Miles	x	
Effect on local transportation: city street circulation and public transit	1. Costs (savings) for improvement to city streets to provide for projected traffic volumes if freeway is not built	Dollars	x	
	2. Net change in parking space available as result of freeway	No. spaces	x	
	3. Number of interchanges with the community less streets closed	Number	x	
Access to regional facilities: recreation, education, culture, business, and employment	1. Travel time savings to regional activity centers [(minutes per vehicle) x (vehicles per day)] for each facility	Minutes per day	x	
	2. Number of trips to community generated from outside	Vehicles per day	x	x
Highway design standards: grades, alignment, and interchange location	1. Miles less than x percent grade	Miles	x	
	2. Miles of curvature less than y radius	Miles	x	
	3. Average distance between interchanges	Miles	x	
Community Planning and Environment				
Land use: land development, changes in use, multiple use, separation of uses	1. Land for potential development to which access is created	Acres	x	
	2. Miles of freeway separating incompatible land use minus miles dividing compatible uses	Miles	x	
	3. Miles adjacent to or through land undergoing change in use	Miles per acre	x	
Aesthetic impact of freeway on community: depressed or elevated, landscaping, structures	1. Miles depressed in residential areas plus miles elevated in commercial areas less miles at grade	Miles	x	
	2. Additional costs of aesthetic improvement in structures and landscaping	Dollars	x	
Noise	1. Increase in dB level weighted by miles residential, and numbers of schools, churches, and similar buildings adjacent to freeway	dB (weighted)	x	
	2. Additional cost of noise barriers in noise problem areas	Dollars	x	
Air pollution	1. Net change in noxious exhaust emissions for projected traffic with and without the freeway	Percent	x	
Neighborhood and Social Structure				
Property values: changes in resale values	1. Increase or decrease (net) over normal trend in property value classified by type of use and distance from freeway	Dollars	x	
Neighborhood impacts: displacement and relocation of people, environmental qualities, neighborhood cohesiveness and stability	1. Number of housing units displaced (or) number displaced as percent of community's total stock	Number Percent	x x	x x
	2. Number of people displaced (or) number displaced as percent of community's population	Number Percent	x x	x x
	3. Net loss of housing—units taken less vacant replacement housing in same price range with comparable financing less new construction planned on vacant land with financing	No. units	x	
	4. Cohesive neighborhoods severed by freeway (as determined by mapping neighborhood boundaries and social characteristics)	No. people	x	x
	5. Neighborhood stability (14, pp. 33-42)	Index No.	x	x
Parks and recreational facilities	1. Acres of parks lost (gained) as percent of total available acres	Percent	x	
	2. Cost of park replacement less compensation	Dollars	x	
	3. Number of parks affected	Number	x	x
Cultural and religious institutions	1. Number of churches taken (or) total attendance affected	No. churches No. people		x x
	2. Additional cost of relocation, excess over taking price	Dollars	x	
	3. Improved access or location for new church facilities	Minutes	x	
Historical sites and unique areas	1. Number of historical areas lost (total affected less those relocated)	Number	x	
	2. Value of monument measured by annual visits per year	Visits per year	x	

TABLE 2 (Continued)
COMMUNITY EFFECTS OF FREEWAY LOCATION AND USE

Factor	Measures and Suggested Measures		Time Period	
	Description	Units	Long Run	Short Run
School system: attendance boundaries, school environment	1. Net loss (gain) in tax base for school system	Dollars	x	x
	2. Number of schools totally or partially taken (or affected)	Number		x
	3. Number of school attendance areas with access to school seriously impaired where boundaries cannot be adjusted	No. pupils	x	x
	4. Increase (decrease) in cost of providing school services because of changes in busing	Dollars	x	x
	5. Net additional cost to the community of relocating schools affected by freeway (plus) cost of noise reduction in schools adjacent to freeway	Dollars	x	
Community Economic and Fiscal Structure				
Effect on tax base: Net change in assessed value of property on tax rolls	1. Loss of assessed valuation in right-of-way as percent of community total	Percent		x
	2. Loss of assessed valuation in right-of-way less increase of land values (assessed) caused by freeway impact	Dollars	x	x
	3. Net loss (gain) in tax revenue caused by freeway impact	Dollars	x	x
Community services: police and fire protection, utility services, water and garbage services	1. Net increase (decrease) in costs of providing fire and police protection and water, sewerage, and garbage service	Dollars	x	
Commercial activity: wholesale, retail	1. Net increase (decrease) over normal trend in gross wholesale and retail sales	Dollars	x	
	2. Net number of businesses located (displaced) by freeway	Number		x
	3. Net number of jobs located (displaced) as a result of freeway	Number		x
Employment: creation of jobs, displacement of jobs	2. Net gain (loss) in gross earnings from jobs located or displaced by the freeway	Dollars	x	x
	3. Net increase (decrease) in job opportunities caused by expanded commuting area less jobs available to outside commuting	Number	x	x

The factors of Table 1 have been divided into quantifiable market values, quantifiable non-market values and non-quantifiable non-market values. The authors recommend that only quantifiable market values stated in monetary terms should be included in the economic analysis. These factors affect those that are not quantifiable in monetary market values such as non-commercial savings in travel time, discomfort, inconvenience, aesthetic considerations should not be included in the economic analysis.

Table 2 list factors and measures that may be useful in evaluating the differences in the community impact of various alternatives. These factors are classified according to: local transportation effects, community planning and environmental land use, neighborhood and social structure property values, and community economic and fiscal structure. The authors point out that even though some of the effects of Table 2 are quantifiable in monetary terms, they are not terms compatible with the market value terms of Table 1 hence should not be included in the economic analysis.

The benefit-cost analysis as proposed by these authors is to have the analysis consist of two parts: "... (a) an economic study that includes all items that can be reduced to money terms and (b) an analysis

of all items that cannot be stated in terms of money but that must be weighed in the decision. The approach proposed for analyzing the indirect and community effects of the second part is called a community factor profile."

The community factor profile represents for each alternative the negative or positive percentage of the maximum absolute value of the measure determined for each factor. Figure 29 presented by Oglesby et. al. presents a simplified version of a community factor profile.

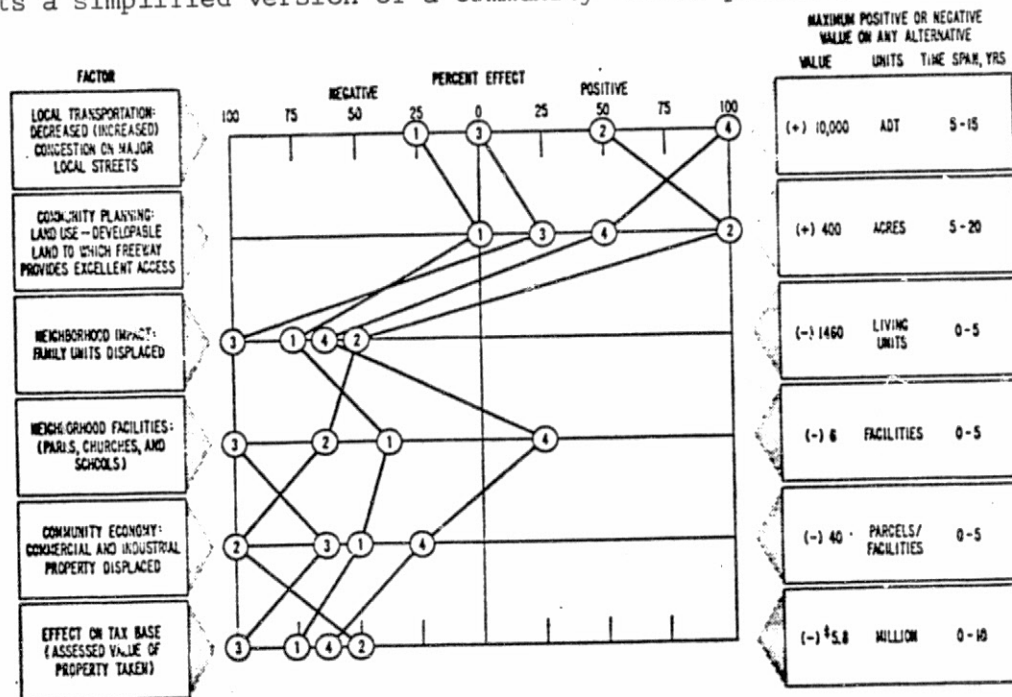


Figure 29. Community factor profile: Numbers in circles indicate the 4 alternatives.

The factors used to develop the profile should describe all of the important elements associated with the community impact. It is important to make sure that in defining the factor measures that the same consequences are not measured more than once. The concept of double counting will be discussed in a later section. The authors suggest that the full set of community factors should be reduced whenever possible by eliminating all factors that are not relevant and by eliminating all factors that have substantially the same value for all alternatives. They also suggest that profiles be prepared for each alternative from the viewpoint of each community interest group as well as a composite profile that would show the total community effect for each factor.

Different alternatives affect various levels of government, communities and groups in different ways so that it is important for the decision-maker to have some insight into how various groups view the factors associated with a proposed project. A survey was conducted using three groups: (1) Highway engineers and planners (2) Community officials and (3) community citizens. Table 3 shows the results of this study.

TABLE 3
IMPORTANCE OF FACTORS IN ROUTE LOCATION TO 54 HIGHWAY ENGINEERS AND PLANNERS,
160 COMMUNITY OFFICIALS, AND 123 CITIZENS

Factor	Percent of Highway Engineers and Planners			Percent of Community Officials			Percent of Citizens		
	Major	Minor	No	Major	Minor	No	Major	Minor	No
Direct costs and benefits of freeway									
Cost of highway	95	4	1	86	12	1	81	18	1
Motorist safety and comfort	85	13	2	84	12	2	87	8	1
Travel time savings	52	43	5	55	40	2	61	31	7
Vehicle operating cost	41	54	5	29	48	21	19	50	29
Local transportation effects									
Traffic service to city	96	4	0	89	8	1	77	20	1
Local transportation	74	20	6	91	7	2	63	31	4
Regional access	50	45	5	65	31	2	55	37	7
Highway design standards	93	5	2	87	11	2	81	16	1
Community planning and environment									
Land use plans	65	32	3	79	17	2	52	37	8
Aesthetics of freeway	69	28	5	76	21	1	42	51	2
Noise	24	67	9	67	28	3	51	42	4
Air pollution	13	52	35	58	33	6	72	22	2
Neighborhood and social structure									
Property values	65	28	7	72	22	2	59	33	6
Neighborhood impact	54	41	5	59	33	5	40	41	17
Parks and recreation	82	16	0	58	34	6	37	51	8
Cultural and religious centers	54	43	3	36	57	4	17	61	18
Historical and unique areas	69	30	1	64	32	2	37	48	11
School system	56	37	7	51	43	5	43	42	13
Community economic and fiscal structure									
Effect on tax base	30	61	9	49	42	7	48	41	7
Community services	32	65	3	71	25	2	61	34	3
Commercial activity	37	50	13	56	39	3	47	43	6
Employment	41	45	14	56	32	8	60	35	2

This table illustrates, in this survey at least, that there is discrepancies between what highway engineers and planners consider important and what the other groups consider important. For example:

- (a) Vehicle Operating Costs - Considered important by planners and not important by community officials or community citizens.
- (b) Air Pollution - Considered very minor by highway planners but quite important by community citizens.

These types of comparisons may be continued to indicate the relative importance that each group place on the various factors. It should be pointed out that this does not result in a factor weighing procedure for the evaluation of alternatives.

The time period on which the affects of the factors is likely to be felt is very important and is included in each of the tables present. This time span gives the decision-maker the information necessary to discount the effects of the various factors and to arrive at an effective planning schedule.

Table 4 indicates the summary of the benefits and costs associated with the four alternatives considered in this paper.

TABLE 4
COSTS AND BENEFITS OF LOCATION ALTERNATIVES

Item	Alternative			
	1	2	3	4
Annual cost, \$	650,000	750,000	850,000	700,000
Annual road user savings, \$	1,000,000	1,200,000	1,150,000	1,000,000
Net benefits, \$	350,000	450,000	300,000	300,000
Benefit-cost ratio	1.54	1.60	1.35	1.43

Table 5 gives the incremental analysis associated with this paper. For more detail on this type of incremental analysis consider the mutually exclusive alternative analysis section of engineering economy.

TABLE 5
INCREMENTAL ANALYSIS

Alternative	Incremental		Benefit-Cost Ratio	Incremental Net Benefit (Cost), \$
	Cost, \$	Benefit, \$		
4 over 1	50,000	0	0	(50,000)
2 over 1	100,000	200,000	+2.0	100,000
3 over 1	200,000	150,000	+0.75	(50,000)
2 over 4	50,000	200,000	+4.0	150,000
3 over 4	150,000	150,000	+1.0	0
3 over 2	100,000	(50,000)	-0.5	(150,000)

To complete the analysis comparisons must be made between the economic and community effects. From the economic analysis (Tables 4 and 5) it is apparent that alternative 2 is preferred. From the community factor analysis alternative 4 eliminates alternatives 1 and 3 therefore the comparisons would begin with alternatives 2 and 4 for each of the factors of the community profile. The decision-maker would then weigh each alternative with respect to the economics, and all factors associated with the community profile to arrive at an optimum decision.

The steps proposed by the authors to accomplish the economic and community impact analysis are:

- Step 1: Engineering Economic Analysis—Rank the alternatives in order of preference as determined by the economic analysis. This may be done on the basis of maximum net benefits over cost or total and incremental benefit-cost ratios or rates of return. Tabulate the net benefits over costs for each alternative.

- Step 2: Factor Profiles—Prepare factor profiles from the viewpoint of each interest group showing the freeway's impact on each relevant factor for that group. Prepare a factor profile also that shows the total or aggregate effect of each alternative over all communities and groups.
- Step 3: Economic and Factor Profile Analysis—Compare alternatives on the basis of the economic analysis and the factor profiles. Eliminate from the set of feasible alternatives any alternative that is dominated by another from the standpoint of both the economic analysis and the factor profile. One alternative is strictly dominant over another if all percentage values of the factor profile of the dominant alternative are greater than that of the alternative. This implies that there are no crossovers in the lines of the factor profiles for the 2 alternatives.
- Step 4: Paired Comparisons of Alternatives—Paired comparisons are made for each viewpoint on the basis of the incremental differences in community effects from the factor profiles and these are then compared with the incremental differences in costs from the economic analysis. Any 2 alternatives can be paired, but a reasonable beginning would be to pair one of the alternatives having a good factor profile with the preferred alternative from the economic analysis. (a) Determine the differences between the alternatives for the community factors, and compare the increments of values gained with the increments of values lost. (b) State a preference between the 2 alternatives based on the importance to the decision-makers of the trade-offs among the factors. (c) Check the preference statement against the ranking from the economic analysis. This resolves the question, "Is the alternative preferred in (a) also superior from the standpoint of the economic analysis?" If the answer is yes, then the preferred alternative is paired with the next alternative selected for analysis. If no, then the analysis proceeds to (d). (d) Test the differences in community factors against the excess of costs over benefits. The decision-maker is asking the question, "Are the gains in community factors worth the additional incremental costs of this alternative?" If the answer is yes, the alternative of higher cost is preferred from the economic analysis is selected and paired against the next alternative for analysis.
- Step 5: Continue Paired Comparison Procedure—Continue procedure (a) through (d) in step 4 until all feasible alternatives have been included in comparisons. The paired comparisons

among the feasible alternatives produce a preferred alternative, and also a preference ranking among all alternatives for each viewpoint if this is desired. [341]

This example has presented one approach to the solution of some of the problems associated with a benefit-cost analysis where social, political, environmental as well as the economic impacts are considered for each of the alternatives, with benefit-cost and are vulnerable to bias.

The example shows that a benefit-cost analysis can force out a detailed structure for each and all the relevant alternatives. But it also has very much room for an inbuilt bias favoring or disfavoring particular decisions. In particular, it does not necessarily correlate to the interests of various different socioeconomic and political groups especially if these groups have limited access to the resources of the society.

4. A PERSPECTIVE FOR AN ANALYST IN BENEFIT-COST ANALYSIS

In the typical managerial and engineering economics applications the perspective for an analyst is that of the private sector market oriented economics in a basically microeconomic setting although several macroeconomic factors can be included. The benefit and cost streams are given in the units of dollars over a unit period or dollars per unit period, and are related to the measures of the various internal and external accounting costs and revenues and market prices of factors of production and goods sold. In a managerial decision making environment the alternatives, including the present situation, are compared in those terms that are more or less under the decision maker's control, i.e. in terms of those to him relevant costs and revenues that he can affect in some manner as a decision maker in some more or less fixed decision background environment. That is, to him his relevant controllable "variable foreground" is extracted out from a total decision making setting leaving behind this "fixed residue" or background environment.

In a managerial and engineering economics study the point-of-view that the analyst assumes will dictate the development of each flow. For example if the view taken is that of a lender or a seller, the cash flow developed would be the inverse of the cash flow developed if the view taken was that of a borrower or a buyer. In these situations the point-of-view taken by the analyst would be determined by the owner of the funds used to establish the project. For replacement studies the point-of-view of the analyst would be that of an outsider. Here the analyst considers all alternatives, including the alternative to keep the present facilities, as if they were to be purchased by the outsider. The point-of-view of the analyst is again concerned with the ownership of the facilities as viewed from the outsiders.

In benefit-cost analysis the analyst deals with a decision environment which includes the public sector over and above the private sector

considerations. Further, it may include a variety of public policy considerations not clearly defined in purely economic terms. The analyst associated with benefit-cost studies is usually working for a local, state or federal governmental agency. However, if tax funds are involved in financing the project, the general public should be considered the owners of the project, not the governmental agency involved. Thus the benefit-cost analyst should consider himself as a representative of the general public and establish the benefits and costs, both economic and social, as they accrue to the various subgroups of the general public. Thus the analysis will show how the various subgroups of the general public might be affected by the project if it is implemented. It must be noted that the benefits and costs are determined under the consideration with and without the new project, not before and after this project. That is, it is important to realize that there are certain changes that might occur after the implementation of a project that should not be attributed in their entirety to the implementation of the project. For example, if growth is present before a project is implemented and continues after implementation, but at an increased rate, not all of the after project rate may be attributed to the project. Viewing the situation with and without the project will eliminate this type of error or over account for the benefits of the project.

The benefit-cost analyst must also be aware of the possibility of biases that may be introduced into the analysis and vested interests that might influence the decision process. Knowledge of the possibility of biases and/or vested interests should be indicated in the analysis structure even though the analyst might not be able to apply corrective measures.

The economic portion of the analysis will include the determination of public subgroups and their benefits and costs from the implementation. The social portion of the analysis will consist of an identification of values and preferences of various groups associated with the changes resulting from the implementation of the proposed project. Establishing values and value preferences of the individuals or public subgroups presents problems due to the different ways that various individuals and subgroups view the inputs required for project implementation and the outputs associated with the established project. The previous example illustrates that in certain situations groups viewed factors associated with determining highway location differently with regard to this importance. In this example the three groups surveyed were; (1) highway engineers and planners, (2) local governmental officials such as commissioners, etc., and (3) local public citizens. This survey showed that these groups viewed the importance of factors such as: vehicle operating costs and air pollution, to name a few, differently. It does not follow, that what the public prefers is best for the public; nor does it follow that what the governmental planners consider important in project appraisal is always best for the public. The analyst, however, must make the decision-maker aware of the different preference structures of the various subgroups so that hopefully a better decision would be made than without any knowledge of various preference structures.

The analyst associated with a benefit-cost study should be aware of the accounting perspective established for the project. For example, should the analysis be restricted to local, regional, national or international considerations? It seems to be accepted that if federal funds are to be used for the project, national accounting should be employed. This requires that the benefits and costs associated with the projects be determined for the entire nation. If the analyst chooses to limit the scope of the analysis this fact should be clearly pointed out. When regional or local analysis is preferred it is important to realize that a benefit to one region might be a disbenefit to another region. Therefore if a larger accounting perspective was used the net overall benefit might be zero.

In a summary the benefit-cost analyst should:

1. View himself as the representative of the general public rather than the employee of a governmental agency.
2. View the analysis as if it is providing the decision maker with valuable information concerning the economic, social and political impacts upon the various subgroups of the general public.
3. View the analysis from the widest feasible accounting perspective required to establish overall benefits and costs.
4. View the analysis from the standpoint of possible biases and/or vested interests that might affect the decision process and thereby potentially distort the intentions of the analysis toward the greatest possible net benefits to a society.

5. TRADITIONAL BENEFIT-COST DECISION CRITERIA

A. Remarks on Welfare Maximization

The philosophical foundations of the traditional benefit cost analysis rest on a welfare economics developed from the Walras-Pareto Perfect Competitive General Equilibrium model and its modifications. The basic measure of welfare in this setting is a pattern of consumption which maximizes the satisfaction or utility of each consumer and all consumers in a society, however in a manner where any interpersonal comparisons of individual preferences are denied, a priori. It will be shown later that this is a very strange one-way justification of welfare which denies a unique de-aggregation of a total demand to individual demands based on any criteria requiring interpersonal knowledge of social needs.

In the traditional benefit-cost analysis the main philosophical concepts of welfare are consumption and its aggregated demand function,

consumer surplus, and the Pareto Optimality and its modifications. The aggregated demand function is obtained by summing all individual quantities demanded for each and all given prices. The price-quantity relationship for each individual - or each individual demand function - is assumed to reflect a maximal utility behavior of the respective individual under the constraint of his own individual limited income. However, individual preferences cannot be compared on an interpersonal basis. Thus, while individual demands are aggregated to a total demand there can be no interpersonal criteria to guide the de-aggregation of the total demand to individual demands. Among others, there can be no social, interpersonal income distribution criteria - such as interpersonally comparable minimum subsistence requirement criteria for each and all individuals - that would be allowed to set a minimum income requirement for the survival of each consumer. This is obviously an absurd situation.

In the Walras-Pareto model the allocation of limited resources is thought to be determined by the individualistic (atomistic) consumption levels of all the consumers and by input and output levels by each and all producers or firms. This allocation is Pareto Optimal if the production and distribution activities cannot be reorganized in any manner to increase the utility of any one or more individuals without decreasing the utility of other individuals. This property is constructed into the Walras-Pareto model which is - as discussed previously - totally atomistic, and, a priori, assumes no "externalities" between any two or more consumers, any two or more firms, and any one or more pairs or combinations of consumers and firms. In a world of highly interdependent industries, consumer groups, markets, and social and political interactions such exclusion of "externalities" is at best highly unrealistic. In particular, Pareto Optimality fails if any "externalities" are introduced. Walras-Pareto model denies the science of social psychology, sociology and political science insofar these deal with behavioral interactions between two or more people in regards to their preferences and the influences of kinds of products on these preferences.

It is only under the highly unrealistic conditions of perfect competition with no "externalities" that market prices reflect "true" individual utility maximization and thereby "true" undistorted individual welfare maximization in the restricted sense of Pareto optimality. Even under such conditions, if the society's resources are so scarce as not to meet the minimal subsistence requirements of each and all of its consumers, some consumers have the "freedom" to exit out of the system by starving to death.

The role of public sector in welfare economics is to introduce beneficial "externalities" and to provide a generation and redistribution of income so that consumers are able to express and assert their preferences. The role of the public sector is to counteract the "imperfections" of the private sector and to complement it in a manner where the total societal benefits are maximized under those constraints and "externalities" that have destroyed the state of the perfect competition.

In a perfect state of a pure Walras-Pareto equilibrium Pareto Optimality provides a standard for economic efficiency. In an imperfect state with externalities this standard can never be reached but supposedly it can still be approached as much as possible under the prevailing private sector externalities or constraints which supposedly could be relaxed by some appropriate counteracting externalities introduced by a public sector. The economic efficiency of a public project can then be viewed in such a total setting where the society's total welfare is measured against the highly unrealistic standards of the perfect competitive model. Such a model, in fact, sets forth a norm regardless how valueless the science of economics is supposed to be.

B. Specific Benefit-Cost Decision Criteria

For a traditional economic benefit-cost analysis of a public project specific indicators of "economic efficiency" are introduced. Such measures or indicators provide typically a cardinal number that allows at least an ordinal ranking of the various alternatives in an order of their desirability in terms of their "economic efficiency".

Examples of measures or indicators that are traditionally used are:

1. Benefit-Cost Ratio.
2. Internal Rate of Return.
3. Maximize Benefits for given Cost.
4. Minimize Costs for given Benefits.
5. Maximize Net Benefits (benefits minus costs).

The evaluating of these indicators requires the manipulation of benefits and costs which are expected to occur throughout the life of the project. To accomplish this, the equivalent present worth of these benefit and cost flows must be determined.

To determine the present worth of a benefit or cost cash-flow, it is necessary to determine or assume:

1. The life of the project or at least the number of years that are to be considered in the analysis.
2. The amount and time of the occurrence of benefits and/or costs.
3. The discount rate.
4. Whether discrete or continuous compounding principles are to be used.

Assume that these four requirements have been fulfilled: The life of the project is for N years, the rate of discount is $r\%$ with an annual compounding period, and the benefits and costs are assumed to occur at the ends of the respective years. Here B_n and C_n are the Benefit and Cost

lump sums occurring respectively during the n^{th} year. The subscript $n = 0, 1, 2, \dots, N$ refers to the discrete points in time at which the benefits and costs occur. When $n = 0$ the time is considered to be present, for $n \neq 0$ the time is considered to be the end of the n^{th} period or year.

Benefit-Cost Ratio

The form of the B/C Ratio is as follows:

$$\text{B/C Ratio} = \frac{\sum_{n=0}^N B_n(1+r)^{-n}}{\sum_{n=0}^N C_n(1+r)^{-n}}$$

B_n is the net benefit to the public expressed as the difference between the respective gross benefit and the respective dis-benefit at the end of the n^{th} year. The net cost term, C_n , is the cost to the public expressed as the respective project cost minus any respective gain resulting from the project at the end of the n^{th} year. The term $(1+r)^{-n}$ is the present worth factor for n years at $r\%$ discount rate.

There are certain disadvantages associated with using the B/C ratio as a decision criterion. Some of these are:

1. There can be problems in the classification of benefits, dis-benefits, costs and gains: Since both B_n and C_n are different terms it is important to realize that subtracting from the numerator is not equivalent to adding the same quantity to the denominator. Thus a misclassification of a dis-benefit as a cost could be extremely important.
2. The B/C Ratio tends to favor projects with relatively smaller first net cost. This results from the nature of discounting. With a large positive $r\%$, future net benefit and net cost streams tend to play a minor role in the B/C ratio. Therefore, the net benefits and net costs that occur early in a projects life are most important.
3. All net benefits and net costs must be measured in the same units (usually dollars). It is conceivable that this may not be, in general, possible.

Internal Rate of Return

The internal rate of return is the interest rate at which the present worth of a series of net receipts is just equal to the present worth of a series of net disbursements. In B/C analysis this is the analogous to the determinates of r such that

$$\sum_{n=0}^N B_n(1+r)^{-n} = \sum_{n=0}^N C_n(1+r)^{-n}$$

The r determined would then be compared with some minimum required rate of return or cost of capital and/or with the r 's determined for the other alternatives.

There are problems associated with the use of the internal rate of return for ranking alternatives. In some situations the rate of return is not uniquely determined. Depending on the nature of the net benefit-cost streams there can be more than one positive real value of r that will satisfy the above equality. It will suffice to say here that there are ways to overcome this problem. However, no satisfactory solution would exist for ranking alternatives by internal rate of return alone. All alternatives should have net costs or net benefits of about the same order of magnitude. The rate of return gives no indication of the absolute size of the net costs or net benefits. Therefore, it is important to restrict the internal rate of return analysis to alternatives with nearly the same net costs or net benefits volumes.

Cost-Effectiveness Criteria: Maximize Benefit for Given Cost or Minimize Cost for given Benefit. These two cost effectiveness criteria are used extensively. They may be used when the measure of net benefits is not necessarily monetary. That is, the units of measure for the net benefits and net costs do not have to be the same.

The cost-effectiveness criteria can be used for the selection of a best alternative only if the net benefits from all the alternatives can be given in the same units; and, further, if the net costs for each and all alternatives are also given in the same units which need not be the units used to measure the benefits.

Maximization of the Net Benefits Minus Net Costs

The present worth of the Net Benefits minus Net Costs flow is as follows:

$$NB = \sum_{n=0}^N (B_n - C_n)(1+r)^{-n}.$$

The project with the largest NB would be "most desirable". It is apparent that this criterion overcomes the classification problem associated with the B/C Ratio. In other words, whether a particular impact was classified as a dis-benefit or a cost would be immaterial in the NB determination. Thus NB really can be considered as the present value of a Net Benefit.

The net benefits criterion is not without disadvantages. For example, the size or volume of the projects (n or B_n) is not considered. The net benefit method tends to favor large projects. These disadvantages

are not serious especially in the cases where budget restrictions and constraints are determining factors setting thereby limits to the size of the projects.

All the above mentioned benefit-cost criteria have been used in practice. However, the maximization of the present value of net benefits or NB seems to be in many cases the least objectionable decision criterion, provided that benefits and costs can, indeed, be measured in the same units.

6. FORMULATION OF A BENEFIT-COST ANALYSIS

A traditional benefit-cost evaluation rests on a supposedly relevant economic theory. In particular, this economic theory may be only normative and does not necessarily reflect the realities of actual economic behavior. These aspects of the foundations of benefit-cost analysis have been discussed previously. Assuming now that an economic foundation for a benefit-cost analysis has been given, to the better or worse, then for each alternative public project under consideration there is a number of factors that have to be considered conjointly.

Steps in the Analysis

For a traditional benefit-cost analysis problem the following two steps are essential: (1) Estimate the benefits and costs for each year of each project; (2) From these estimates evaluate the decision-criteria chosen to represent the economic desirability of the project under consideration. Prior to the estimation of benefits and costs, consideration must be given to questions such as the following ones:

1. What accounting stance should be associated with the analysis? Does the impact of the project relate to an individual, local, state, national or international government or organization? The answer to this question would be determined from the size of the project, the governmental agencies affected and the type of funds used for financing.
2. What time interval should be considered in evaluating the impacts of the project? When should this time interval start?
3. What decision criteria are to be used to determine the feasibility of this project or rank this project against other alternative projects?
4. What discount rate or rates should be used to generate and evaluate the decision criteria?
5. What benefits, disbenefits, costs and incomes are to be considered in the analysis?

Once questions such as these have been answered the analysis may proceed in the two stages indicated earlier and restated here as: (1) Estimate the benefits and costs for each year of the project. Determine to whom and how these benefits and costs are distributed; (2) From these benefit and cost streams evaluate the decision criteria selected to represent the economic desirability of this project.

Time Considerations

In the development of the decision criteria it was assumed that the duration of the project was N years. It is assumed that there is some finite length of time for which all the relevant benefits and costs of a particular project are known with some degree of certainty. If the analysis is extended beyond this duration of time, the knowledge of the relevant benefits and costs becomes increasingly uncertain and can be discounted with high enough discount rate to be negligible in their contribution to the present values of costs and benefits.

The duration of the project given by N will depend on the type of project under consideration. For instance a dam, highway or recreation facility would be expected to provide useful service for a long period of time, while a communication satellite would be expected to provide useful service for a relatively short period of time. It is reasonable then to equate N to the economic or service life of the project. If the project consists of elements that have different service lives, then replacement of various elements is assumed so that the project is able to provide its intended function for its required or estimated N years of life. This life may be equal to the life of its most expensive and/or durable element.

Determining the economic or useful life requires the predictions and/or estimations concerning the lives and costs of the elements of the project. Consideration must be given to the various forms of obsolescence such as those due to

1. Technological change.
2. Changes in demand requirements.
3. Changes in physical and economic operating requirements.
4. Reliability, availability, administrative and logistics requirements, including
 - i. Maintenance
 - ii. Replacement

It is obvious that using an estimate for N introduces an element of uncertainty into the analysis. It is also obvious that if the analysis employs the discounting technique, then the present worth of a net benefit stream for 100 years would be only slightly higher than the same net benefit stream discounted over 50 years at -for example- 8% discount rate. To illustrate this consider a net benefit annually for $N = 10, 20, 30, 40, 50, 100$ years at $r=8\%$. The present worth of this net benefit stream NB is:

N	(P/A, r%, N)	A	NB
10	6.710	\$10,000	\$ 67,100
20	9.818	10,000	98,180
30	11.258	10,000	112,580
40	11.925	10,000	119,250
50	12.233	10,000	122,330
100	12.494	10,000	124,940

It is apparent from this that precise knowledge of N is important for projects with rather short lives. It is also true that these short run projects tend to enjoy relatively greater accuracy in predictive techniques, so that errors in prediction or estimation could conceivably be reduced. If a criterion uses annual cost calculations rather than present worth, then the determination of N is critical for all projects.

The present time, $N=0$, is the beginning of the first compounding period. This time should coincide with the date when the project receives approval.

Discount Rate

The present worth of a stream of net benefits is very sensitive to the discount rate chosen. The discount rate selected may make the difference in the selection of a particular project, i.e. whether it is economically feasible or not. Low discount rates tend to favor public investment, whereas high discount rates tend to make such investment harder to justify. The selection of an appropriate discount rate is not obvious and there is no agreement among or within the governmental agencies on what discount rates to use. Table 6 presents a listing of several benefit-cost studies and their respective discount rates used.

TABLE 6
DISCOUNT RATES USED IN BENEFIT COST STUDIES

Issuing Agency	Project	Discount Rate	Date
Dept. of Agriculture	"Benefit-Cost Analysis of Research on Live Poultry Handling"	5.0	1967
Corps. of Engineers	Chanplin Waterway (St. Lawrence Seaway)	3.125 2.625	1965 1962

Transportation	Urban Commutation Alternatives: Special Study	10.0	1968
Defense	Shipyard	10.0	1968
FAA	Radar Components	4.2	1969
TVA	Hydroelectric Power	4.5 to 5.5	1969
Office of	Job Corp.	3.0 to 5.0	1969
Economic	Upward Bound	3.0 to 5.0	1969
Opportunity			
Agency for International Development	Bolivian Highway	12.0	1969
State of Calif. Dept. of Water Resources	California Aqueduct	3.5	1959

This table indicates that there are considerable variations of discount rates over time reflecting, among others, changes in the policies of agencies in selecting such rates. In 1962 Senate document 97 suggested the use of a discount rate equal to the interest rate paid by the U.S. Treasury on commitments extending over 15 years. Document 97 also suggests that the discount rate be adjusted as the cost of borrowing changed.

In 1968 the Joint Economic Committee published a report which asserts that the appropriate discount rate is the opportunity cost of displaced private spending. To arrive at this conclusion they investigated the following three discount rate concepts: [342]

1. The social rate of time preference.
2. The cost of Treasury Borrowing.
3. The Opportunity Cost of displaced private spending.

1. The Social Rate of Time Preference

The proponents of this criterion for the determination of the discount rate argue that the observed interest rates in the private sector of economy give no indication of the appropriate public discount rate. They reason that there are imperfections in the capital market, and this market does not necessarily reflect the desires of the public to provide long run needs for future generations. It is suggested that for such needs the social discount rate be low which would result in the justification of more long-run public investments. The committee noted three shortcomings of this concept:

- a. It is not necessarily clear that there is a collective willingness to transfer income from the present to future generations.

- b. A better way to aid future generations could be through a more rapid rate of economic growth. This might favor higher discount rates also for public projects.
- c. A low social discount rate would apply only to the public sector, thereby lowering the rate of national economic growth (in terms of the conventional economic theory).

2. The Cost To The Treasury of Borrowing

This criterion in one or another form has been employed by some agencies since 1962. In 1965 the Secretary of Treasury pointed out that this approach was, perhaps, misleading due to the methods of calculating the cost of borrowing. The government does not act as a private investor, since it is assumed that it should act as an investor to sustain and complement the private sector rather than to "exploit" the private citizens restricting thereby their free choices for investment opportunities.

3. The Opportunity Cost of Displaced Private Spending

This criterion was selected as being the most desirable approach for the determination of the discount rate for B/C Analysis. The proponents of this criterion argue that the objective of the government as an investor should be the maximization of the overall welfare of the nation as a whole, this welfare being reflected by the national income. Therefore, no public investment should be undertaken if it earns a rate of return that is less than the alternative use of the funds consumed by the project. Thus, if funds are taken from the private sector for the public use they must earn at least as high of a return as they would earn in the private sector.

Even though the committee recommended this concept they realized the difficulties associated with its implementation. They did suggest certain questions that need to be answered and three methods that maybe used to determine the appropriate discount rate. These questions to be answered are: [342]

"In examining . . . foregone opportunities, and then identifying the opportunity costs, one must ask these questions:

- a. Where would the resources have been used in the absence of the particular public investment--in the public sector or in the private sector?
- b. If the resources are drawn from the public sector, that is, if the particular public investment is at the expense of other public expenditures within a fixed budget, what return would have been earned?

- c. If the resources are drawn from the private sector, are they obtained through taxation or through additional government borrowing? If general fiscal policy considerations require that the additional resources be obtained through taxation, one must postulate a specific set of tax changes in order to identify what private expenditures are foregone, and one must then measure the returns in those alternative uses. If general fiscal policy permits the public investment to be financed by public borrowing, one must trace what private investments are foregone because of this particular government claim in the capital market.
- d. Does the public investment preempt a private opportunity at the physical site, or in the same product market, or in utilizing a scarce natural resource? If there is preemption of private investment, an additional test must be performed to assure that the public investment is superior to the preempted private opportunity."

In opting for this conceptual basis, however, the subcommittee recognizes that the estimation of an interest rate representing the cost of displaced private spending is not a settled matter. In testimony before the subcommittee, three distinct methods for estimating this rate were suggested. Each of these procedures assumes a different method of financing Federal investment and, consequently, each finds a different pattern of private spending displaced. These positions are summarized as follows:

- "a. The opportunity rate of return on private investments.-- In this approach, the public sector would look to the before-tax rate of return on private investment for guidance on interest rate policy. This position presumes that any holder of funds in the private sector has access to investments with this high rate of return and, therefore, this rate has normative significance for social interest rate policy.
- b. The opportunity cost of tax-financed investments.--This approach to interest rate estimation assumes that the Federal Government finances its spending by withdrawing funds from the private sector through taxes. Because the imposition of taxes forces some individuals to forego consumption and other individuals to forego investment, the opportunity cost must reflect some combination of both types of sacrifice. To calculate this rate then requires that dollars raised in taxes be traced to their ultimate source so that the social returns foregone in these sectors can be estimated. A carefully worked out model for calculating this rate under various taxation assumptions was presented to the subcommittee.

- c. The opportunity cost of public investments financed by borrowing.--Instead of presuming that the Federal Government obtains investment funds through the tax mechanism, this approach assumes that public investments like some private investments, are financed through the capital market. The estimation task in this case requires that the dollars borrowed be traced through the economy to ascertain the private activities which are displaced. This approach to opportunity cost estimation was described to the subcommittee as follows:

[To] use private sector rates of return to obtain the opportunity cost of public funds, what is clearly called for, at least under present institutional arrangements in the capital market, is a weighted average of the rates of return applying in all relevant sectors of the private economy, the weights reflecting the degree to which investments in each sector is estimated to be displayed by public-sector borrowing."

It must be noted that the members of the committee were not unanimous in their endorsement of this concept. Of a particular note is the view of Representative Patman who ends with the following comment:

"I must, therefore, disagree with the conclusions expressed in this committee report with respect to the appropriate discount rate for evaluating Government investments. Our society has many objectives which could never be shown on a profit-and-loss statement, and our Government has obligations to its citizens which cannot be dismissed by reference to a profit-maximizing rate of return."

It is apparent that the evaluation of the economic feasibility of a Governmental investment is only one aspect of the overall analysis of public projects with possible social and political impacts beyond the realm of conventionally accepted economic impacts. A total assessment of a public project can conceivably be far more complex than suggested by the conventional economic theory.

In 1970 The Bureau of Budget suggested that a minimum discount rate of $4 \frac{7}{8}$ percent be used. They also concluded that the opportunity cost of public investments was 7.8 percent. In taking into account inflation of 1970 The Bureau of the Budget ordered all agencies to use a discount rate of 10 percent. However the Water Resources Agencies were able to maintain the $4 \frac{7}{8}$ percent rate.

A minimum acceptable discount rate provides a base from which one can build up to a discount rate that will reflect the opportunity cost of the Governmental investment, the inflation rate, and if desired, the

economic growth rate. With certain restrictions the present policy allows the agencies to justify and use a discount rate other than that set forth by the Bureau of Budget, as in the case of Water Resources. This policy, it seems, places an undue burden on those agencies that are subjected to the higher discount rates.

7. SELECTING BENEFITS

The selection of benefits depends naturally on the nature of a particular project. Some examples are given below:

a. Flood Control.

Possible benefits that might result from flood control measures are:

1. Savings resulting from the elimination of costs required to handle flood emergencies.
2. Increase in income resulting from more intensive use or change in use of flood plane lands.
3. Income resulting from recreational, irrigation and hydroelectric facilities created by the flood control project.
4. Reduction in the costs of damages prevented by reduced flooding.
5. Reduction in loss of life.

b. Human Resources.

Expenditures in the areas of health and education are considered investments in human capital. Possible benefits resulting from such expenditures are:

1. Increase in expected personal income over the life of an individual taking advantage of the program.
2. Improvement in the quality of personal and community life etc.

Benefits derived from expenditures on health project are:

1. Expected personal income over the life of an individual.
2. Reduction in the cost of health and medical treatments.

3. Reduction in suffering, loss of lives and disability.

c. Transportation

Some of the more general benefits derived from investments in transportation projects are as follows:

1. Cost savings over the present system resulting from reduced travel time, reduced travel costs etc.
2. Reduction in injuries and loss of life due to improved safety.
3. Increase in the value of land.
4. Improvement in aesthetic values.

d. Weather monitoring and disaster warning systems.

Benefits resulting from expenditures to improve weather monitoring and forecasting as well as natural disaster warning capabilities are:

1. Added reduction in injuries and loss of life.
2. Added reduction in property loss and damages.
3. Added decrease in the costs required to handle temporary emergencies.
4. Added reduction in mental and physical stress resulting from increased reliability of the forecasting and warning system.

In general benefits result when implementation of the project results in additions to real resources. They may be classified as:

Direct	- Indirect (external)
Primary	- Secondary
Tangible	- Intangible
Efficiency	- Non-efficiency

The objectives established for the project will provide basis of the selection of particular benefits and then measurement. In the past many benefit-cost studies considered only the efficiency objectives, i.e. the maximization of the economic welfare measured as a change in gross national product. More recently a variety of public policy objectives such as equitable distribution of income, national security, national defense, stabilization of the economy and balance of international payment have

been considered in the evaluation of the desirability of public expenditures. Not all of the benefits selected under each of these objectives can be quantified to show a change in the gross national product. Therefore, a problem exists when several objectives are considered relevant to the same project. To overcome this problem the measures for each objective must be made commensurable. For example when the efficiency objective and the equity objective are present in the same project, then a rate of exchange or trade off between the two types of objectives must be established. Work has been done by Weisbrod, and presented in Chase [343], which divided the population into four groups according to income and race. That is white, non-white with income under and over \$3,000. Weisbrod establishes weights for each group's net benefits which was then added to a total net benefit. The establishment of weights such as these is highly controversial and it is unlikely that any announcement of specific weights tied closely with social economic groups would be acceptable. The problem of weighing and trading off between economic and non-economic objectives continues to plague decision-makers, and is one which requires extensive research.

8. SELECTION OF COSTS

The selection of costs to include in a benefit-cost study depend in some measure on the type of project under consideration. They should include, however, all items that consume real resources. In general they may be classified into:

1. Non-recurring Costs (Initial)
2. Recurring Costs (Annual)
3. Opportunity Costs
4. Associated Costs
5. Social Costs

Non-recurring costs include the costs necessary to conduct the research and development, to provide the equipment and the services that are essential to the project. The costs associated with the initial investment in equipment, building, land and construction are also considered non-recurring costs. Non-recurring costs may be expanded over several years. However, once they are expanded they do not occur again throughout the life of the project. These costs are important in establishing budgetary figures, and are often considered as the initial investment.

Recurring costs are annual operating, annual maintenance and equivalent annual replacement costs. These are costs that are considered to occur annually throughout the life of the project. They are not necessarily equal annual cost. However they may be converted to equivalent equal annual cost.

Remaining costs are discussed under item 10 on page 182.

9. BENEFIT MEASURES

A. Consumer Surplus

The Marshallian consumer surplus in a perfect competitive case and in a situation of partial analysis is often considered as a measure of benefits. This measure is meaningful only if consumption uniquely measures welfare and if the highly unrealistic Walras-Pareto equilibrium exists so that the consumers' aggregated demand would truly reflect their utility maximization and thereby actual preferences in the setting of a partial analysis and with no "externalities" present.

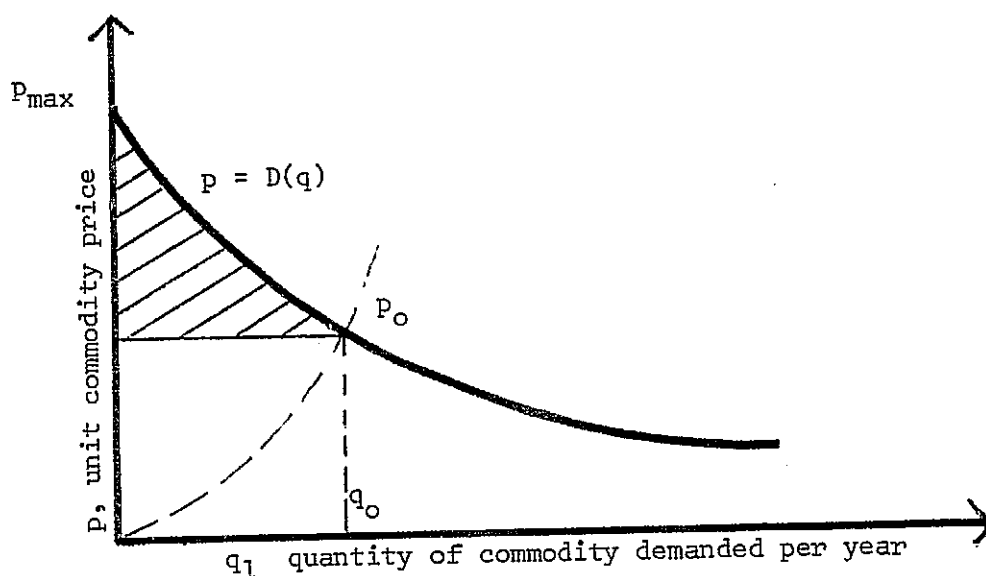


Figure 30. Consumer Surplus

Then, if p_{\max} is the top price the consumers want to pay for the commodity and if p_0 is the prevailing market price, then the respective consumers' surplus C.S. is as follows:

$$\text{C.S.} = \int_0^{q_0} D(q) dq - p_0 q_0$$

Where $p = D(q)$ is the consumer demand function. Further, the consumers would receive a market value $p_0 q_0$ if they purchase q_0 units at a market price of p_0 . Therefore, the total value T.V. or benefit to the consumers would be

$$T.V. = C.S. + p_0 q_0 = \int_0^{q_0} D(q) dq$$

As was pointed out above, in the development of the consumer surplus the condition of perfect competition, was necessary. In a perfect market economy the market price is supposed to reflect the consumers' marginal valuation, the producers marginal costs reflect the amount of additional resources that must be sacrificed in order to produce an additional unit of good; and the Pareto-optimal allocation requires that the market price is the same as the producer's marginal cost.

Even if perfect market conditions are assumed to apply and the nature of the projects and objectives of the project are such that market prices are available for the evaluation of the project outputs, it is still difficult to obtain the total value of the project's output. If price differentials are used in an effort to establish the consumers' surplus portion of the total benefit, care must be taken because not all consumers value the good to the same extent. In fact the aggregated demand functions cannot be appropriately de-aggregated if interpersonal comparisons of individual preferences are denied, a priori. If direct surveys are made in an effort to determine individual's willingness to pay, care must be used because their assumed willingness to pay might not be the same as their actual willingness to pay. The market price - if one exists - may be used as an approximation to the total willingness to pay. If the respective approximation of benefits exceeds the costs, then it would appear that any hypothetical price used to represent the total willingness to pay will serve only to increase the value of the benefit, being useful only when comparing competing alternatives.

B. Shadow Prices

When no market price is available to evaluate the output of a project it may be possible to determine in certain situations the willingness to pay by indirect means. For example, it is possible to approximate the value individuals place on travel time by examining their travel behavior. That is, hypothetical or actual demand curves are developed for more expensive modes of transportation and the time savings are related to the increased cost of transportation. Another example is that of evaluating the benefits from a recreation facility. Benefits from a recreational facility have been related to the amount that individuals pay to travel to and from the facility. Prices determined by indirect methods or by methods not directly related to the assumed market mechanisms of the Walras-Pareto system are called shadow prices. A shadow price is necessary in economic calculations when a market price does not exist or does not reflect the "true" consumer preferences.

In the two above examples the methods of using shadow prices to evaluate benefits that have no market price have been considered successful. Attempts to use shadow prices to evaluate benefits such as reduction of noise level, aesthetic values, reduction in air pollution and reduction in loss of life have been considered less successful.

C. Intangible Benefits

Intangible benefits are considered to be benefits that cannot be measured in physical terms. Most of the analytical development of benefit-cost analysis has been in the area of finding suitable measurement techniques for intangible benefits. This has resulted in various attempts to translate intangible benefits into tangible benefits in a framework of the traditional economics. It seems that research is continuing for the inventions of suitable measures of intangible benefits within and without an economic theory.

It seems very desirable that the benefit-cost analyst should include all relevant intangible benefits in the analysis because even crude measures of value can be useful indicators for the decision-maker. However indiscriminate subjective evaluations of intangible benefits should be approached with caution, especially in regards to possible influences of biases.

In developing the demand curve and costs associated with the project it is important to recognize the interdependence of various aspects of the project. For example if the project is to improve port facilities at one location, the result might be increased shipping activity at that location while adjacent locations might suffer a reduction of shipping activities. This requires the utilization of the systems approach to the entire nation as opposed to a regional or sub-optimization approach.

D. Double Counting

A potentially serious problem associated with regional sub-optimization is that of double counting. McKean [344] gives several examples of double counting one of which occurs in the case of an irrigation project. In this situation McKean asserts that double counting occurs when the "...Value of the water (that is the amount the farmers would pay for the water), the value of the crops made possible by the water, the value of the livestock made possible by the crops, and the value of the milk products made possible by livestock", are all included in the analysis. It may be argued that if these benefits produce an increase in the national income then they should be counted. This leads to the controversy of secondary benefits.

E. Secondary Benefits

Secondary benefits may be defined as benefits that are induced or stem from the project. In the irrigation project several examples of secondary benefits, such as benefits occurring to industries using the outputs of the project, were given. Secondary benefits may also be induced by the project such as money spent on the project that is respent in the region with its possible multiplier effects. There has been much controversy concerning the inclusion of secondary benefits in a B/C analysis. This controversy ranges from excluding them totally from the analysis to such claims as that by Maass stating that no benefit is

secondary. Recently secondary benefits have become known as "Regional Development Benefits", and whether they are included in the analysis or not seems to be at the discretion of the agency performing the study. It does seem logical that if the secondary benefits produce an increase in the regional or national income, then they should be included. It must be cautioned here that these secondary benefits are determined as a net income of productive factors associated with the project minus the net income of the productive factors without the project. Thus the analysis is a with and without project analysis rather than a before and after project analysis.

F. Spillover Effects

Another type of benefit that does not directly accrue to the decision-making agency is that of spillover. In economics these kinds of benefits are called external economies or diseconomies and may include costs as well as benefits. McKean [344] indicates that there are two types of spillovers: the "Technological Spillovers" and the "Pecuniary Spillovers".

Technology or "real" spillovers should be included in the analysis because they represent impacts that affect the physical inputs or outputs of individuals or agencies other than the decision-maker's. An example of a technology spillover would be a project that pollutes the air or stream. This would result in a real cost to the local residents hence should be accounted for. According to McKean, pecuniary spillovers, on the other hand, are impacts that do not affect the physical inputs or outputs of individuals or agencies that are outside the decision-making unit and hence should not be included in a B/C analysis.

McKean [344] discusses four types of pecuniary spillovers:

1. Bidding up factors rates of hire
2. Cutting down prices of substitute products
3. Raising prices of complementary products
4. Lowering the price of the outputs

These types of pecuniary spillovers are all occasioned by shifts in prices as a result of the project implementation by the decision-maker with the result that these spillovers affect individuals or agencies other than the decision-maker. McKean argues in support of exclusion of pecuniary spillovers by noting that the "...resources are being reallocated to uses where they are more valuable, and rents are being transferred". He indicates that as far as the efficiency of the economy is concerned the decision-maker should not have to account for the non-decision-maker losses in a B/C analysis. The contention is that to include pecuniary spillovers in a B/C analysis is double counting. For example if a transportation project improves accessibility then the savings in time to commuters should be counted, whereas the increase in land values should not be included as this would be double counting.

10. COST MEASURES

The estimation or prediction of costs are usually much more easy than the estimation or prediction of benefits. This is especially true when the costs are those associated with the project outlays or direct costs.

a. Direct Costs.

Direct costs associated with a project are those of:

1. Research, Development and Testing
2. Investment
3. Operations
4. Maintenance
5. Replacement

These are typically the kinds of costs usually treated in managerial and engineering economics.

b. Other Costs.

There are other costs or disbenefits that must be considered in establishing the total cost associated with a project. In benefit-cost analysis the following costs are important:

1. Opportunity Costs - opportunity costs are the gains foregone by the funds that are committed for investment in the project under consideration. To determine opportunity costs, knowledge of the other relevant existing opportunities must be obtained. It is important to note that opportunity costs exists for resources other than capital. The determination of opportunity costs is a complex matter and, as indicated in the discussion of the determination of an appropriate discount rate, subject to a great deal of uncertainty.
2. Associated Costs - associated costs are costs incurred by beneficiaries in utilizing the output of the project. Associated costs have, as in the case of recreational facilities, been used as an indication of the willingness to pay. Thus travel costs, admission costs and other costs related to getting to and using a recreational facility have been used to assess the amount that individuals are willing to pay for the facility.

3. Social Costs - social costs may be viewed as the amount of payment to persons who suffer from the implementation of the project so that they would be indifferent between having the payment and the project or no payment and no project. Social costs include opportunity and external costs.
4. External Costs - external costs are costs or disbenefits resulting from the project and are external to some institution or group of individuals. They are usually defined to be external to the governmental investing agency so that the costs to the agency would not reflect these external costs. They may be classified as in the cost of benefits into technological and pecuniary costs.

A technology externality exist when there is possibility of reducing the output for a given input as a result of the action of an agency that is external to the agent associated with the input and output activity. A pecuniary externality results from the reduction in output of a third party due to changes in demand brought about by the project. It is usually accepted that technology externalities should be included since they reflect real gains or losses. While pecuniary externalities should not be included because they reflect transfer from one section to another through price changes, thus to include them could be desirable counting.

11. UNCERTAINTY

In assigning monetary values to the benefits and costs as they are expected to occur over the life of the project, an analyst must predict the future. The use of forecasts introduces uncertainty into the analysis. A basic problem is how to compensate for the respective induced uncertainty associated with the prediction and forecasting of a possible future.

It is important to realize where uncertainty may enter the analysis. The uncertainty introduced by the estimation of N the length of time of the project has already been discussed. The problems encountered with selecting a discount rate to use in the analysis have also been considered. The other major area for introducing uncertainty into the analysis is that of forecasting the occurrence and amounts of the future benefits and costs.

The treatment of uncertainty and decision making under risk is traditionally treated in the framework of statistical decision theory and its extensions into game theory. Typically, a far more serious problem than the uncertainty and risk is the problem of ignorance associated with the future and the ignorance related to problem definition and formulation for decision making.

12. SENSITIVITY ANALYSIS

In a sensitivity analysis a range of possible values are assigned to the uncertain factors and then the decision criteria are evaluated for all possible combinations of the uncertain factors. This could require an extensive number of determinations of criteria. It appears possible to limit the number of determination of criteria by the branch and bound method or grid search method. If the factors can be considered independent so that no interaction would exist between them, the determinations may be reduced by optimizing each factor individually.

It is important to realize that information gained in obtaining the data should be used whenever possible to reduce the effort required in coping with uncertainty in a benefit-cost analysis.

VII. EVALUATIONS OF ECONOMIC IMPACTS

1. INTRODUCTORY COMMENTS

The traditional benefit-cost analysis is based on a static and exceedingly idealized economic theory ill-fitted to account for a multitude of economic, social and political interactions over time and over space in a political and geographic setting. This static traditional economic theory ignores demographic dynamics, technological progress and institutional changes as well as the various limits to economic activity and its growth induced by various finite natural resources such as space for the "lebensraum" in a world where the various impacts of such changes over time and space seem rather obvious. The Walras-Pareto model and several of its modifications are idealizations growing out of an 18th and 19th century "old economics" which is ill-fitted to portray the 20th and 21st century worlds with global interdependences and interactions in strategic and economic arenas. While the world is still politically divided it is fast becoming economically integrated. The transformations from hunting and pastoral societies to agricultural societies then to technological industrial urban societies is now thought to progress toward a global "super industrial" society with a mesh of superimposed global interdependences of economic, social and political nature. In such a setting the various traditional and basically short-run static micro and macroeconomic models can hardly be expected to serve a useful purpose for policy, strategic and operational considerations and needs. In particular, the traditional welfare economics and benefit-cost analysis do not provide, even philosophically, and adequate, relevant, and meaningful base for economic impact analysis, which clearly must belong to a realm of considerations of economic development over time and space.

Further, economic development should be understood in a social, institutional, political and historic perspective with the full understanding

that economic development, indeed, deals with open systems rather than with such artificially closed systems as the Walras-Pareto General Equilibrium model. This would suggest that an economic impact evaluation may have to be augmented by social, institutional and political impact evaluations. While traditional micro and macroeconomic theories have often been short-run oriented and highly exchange market oriented, economic development models, in a contrast, attempt to include population, technological and institutional dimensions and their influences on total real economic activity in the long-run.

2. SPATIAL AND GLOBAL MACROECONOMIC IMPACT ANALYSIS

The long-run effects of fiscal policy and public programs can be expected to be reflected over time and a geographical space not just in a local region, but eventually globally. Such effects cannot be analyzed just in terms of short-run static exchange market mechanisms typically assumed for traditional economic analysis. Besides exchange market effects, public programs can have direct or indirect "exogenous" impacts or "external" effects on political, social, institutional, technological and economic activities not restricted just into a specified region but having eventually also global impacts.

Relatively recently economic development theories have evolved also in the direction of regional, interregional and spatial settings of macroeconomic development [161,162,163,164,165]. While at the present accounting schemes for space-time economic development are still in their infancy, several indirect measures such as demographic dynamics and agglomeration (e.g. - urbanization and suburbanization patterns over time), technological changes affecting for example, production, transportation and communication as well as consumption activities, and consequent institutional and political changes, do provide indicators that could be used to make at least some meaningful assessments of actual and possible impacts of public projects.

It has been pointed out previously that aggregation has certain advantages and disadvantages in economic analysis. One of the disadvantages is that overt aggregation can assume away important economic, institutional, social and political structural effects without which the understanding of the processes of economic development may be exceedingly inadequate. While traditionally macroeconomic theories have been decomposed into inter-industry and interregional input-output models, very little has been done to view the consumers' sector from a structural point of view emphasizing differing social, psychological, economic and political groups with certain spatial or geographic distribution patterns.

It is interesting to note that private sector firms have found the traditional Walras-Pareto Theory of consumer behavior operationally unsuccessful, and have resorted to socioeconomic, cultural, political, psychological, anthropological, etc. studies in order to segment a marketplace

for particular products that match particular social groups with their peculiar and measurable characteristics. This, indeed, is an approach recognizing group preferences in terms of operational, empirically measurable characteristics. While political scientists point out similar approaches are also useful in analyzing prospective election results, the public sector benefit-cost analysis has been blind to the practical marketing approach now evolving in the private sector. Since citizens are not a homogeneous group with homogeneous patterns of desires and equal access to social, economic and political activities and, thereby, to society's scarce resources and enjoyment thereof, all public projects must be expected to have respectively different impacts on these different social groups. The traditional micro and macroeconomic theories are ill-fitted to treat such different impacts on the respective different social groups. It appears only sensible to ask a question whether a segmentation of the total citizen's group into some specific social group would yield to the planners and decision makers of public programs an approach for differential impact analysis in a practical operational manner as indicated by the marketing and market segmentation activities of the private sector.

It should be noted that a segmentation of public into specific groups of citizen-consumers is an empirical matter leading potentially to an "input-output" structure of the consumers' sector, interacting -for example- with an input-output structure of the industry. Further, such structures also can be extended into interregional input-output structures. In a contrast to the traditional welfare economics and benefit-cost analysis, all this structural modeling and accounting can be done in a framework of economic development.

The traditional neo-classical economic development theories have not been very successful as policy sciences in the care of the so-called developing or "third" world. A part of the problem seems to relate to institutional, social, political, cultural and historic processes that such models are ill-fitted to portray. This would suggest that these "exogenous" processes cannot, indeed, be ignored in an economic impact analysis; and, more explicitly, socio-political impact analysis should be considered as a necessary complementation of the economic impact analysis. This is merely an admission that economic development systems remain open to socio-political and institutional aspects of a society not only in a regional but also in a global setting.

3. REMARKS ON TOTAL ASSESSMENT OF PUBLIC PROJECTS

It has been suggested above that the impacts of public projects can occur in several dimensions many of which cannot be accounted for in terms of the traditional benefit-cost analysis. This in turn suggests that the assessment of the public projects must include all the relevant and important institutional, social and political dimensions affecting and impacting a society outside of the realm of a short-run exchange market oriented economics. An assessment profile for the evaluation of a public

project can be expected to consist of factors and measures not necessarily reducible to any meaningful monetary terms. A way of developing a Total Assessment Profile (TAP) for the purposes of evaluating public projects will be discussed subsequently.

VIII. THE SOCIAL SCIENCES IN PERSPECTIVE

1. INTRODUCTION TO THE SOCIAL SCIENCES

The major function of the social sciences is to help us understand how societies work. By societies we usually mean two or more people interacting in a patterned manner. In a very broad sense, society can consist of as few as two people or as many as exist on earth.

The study of social science is not usually thought of as just one field, but rather is divided into a series of areas or disciplines. Generally social sciences are felt to include seven such disciplines: sociology, economics, political science, anthropology, human geography, psychology and history. Other schemes also include philosophy.

Sociology, economics, and political science are generally held to be the central or core disciplines. At one time or another all three of these disciplines proclaimed themselves to be "^{QUEEN}given" of the social sciences. While none claims this distinction any longer, sociology does claim to be synoptic. This perhaps stems in part from the early development of sociology.

2. SOCIOLOGY

Generally, Sociology developed out of political philosophy, history, social and political reform movements, and the biological theories of evolution. The history of this discipline can, for example, be traced through the works of Durkheim, Weber, Marx and Comte to the writings of Hegel and Saint-Simon. While these writings tend to be philosophical they also contained important notions of development and progress. Additionally, they focused on social institutions, the nature of society, population, stratification, and the social system. The development of methodology designed to get at regularity and prediction also constituted an important developmental step in Sociology. A still later development consisted of applying the methods and theories of the discipline to the analysis and solution of social problems. The social survey became an important tool to this applied type social science. This era led to considerable revolt against Sociology which in turn led to a more precise specification of the discipline and the emergence of many specialty orientations.

Perhaps the strong contribution Sociology has to make to modern day social science lies in its concern explicitly with social life as a totality. It is concerned with the whole intricate network of social institutions and groups which make up a society. T. B. Bottomore [166] summarizes the basic conception or guiding idea of Sociology as:

"...social structure: the systematic interrelation of forms of behavior or action in particular societies."

However, Bottomore points out one rather serious problem with regard to this major conception and that is, there are several aspects of social life subsumed under this general directing idea. For example, the family, kinship systems, religion, deviant behavior, social stratification and, urban life, are all foci subsumed under this general conception. Bottomore notes, "the preoccupation with some of these 'residual' subjects may be carried to excess, but the study of such phenomena is an important part of sociology, and properly considered, it is inseparable from the study of economic and political institutions."

3. ANTHROPOLOGY

The problem of over emphasizing the more residual aspects of social structure has been more appropriately considered in the works of the social-anthropologist according to Bottomore. This stems in part from their dealings with small-tribal societies. They have been able to view them as totalities and, as such, investigate every aspect of behavior. However, Bottomore further notes, "they have tended to ignore the historical development of societies, and to reject comparative studies in order to concentrate upon giving a very full account of the social life of particular communities." [166] The major difference between sociology and social anthropology appears then, to lie in the more "holistic" approach the anthropologist brings to the analysis.

4. ECONOMICS

Economics is that branch of social sciences which deals with society's allocation of scarce resources for alternative end uses such as production, distribution and consumption of services and goods; and the interaction of this society with other societies through imports and exports of raw materials, finished and semifinished goods, people and technological know-how. It is emphasized that economics is not an isolated science but relates very essentially to all other social sciences mentioned here.

The various social groups in a society access more or less differentially through various institutions the control and utilization of scarce economic resources and activities such as production, distribution and consumption of goods and services. For example, income distribution is a measure of such a differential ability. Preferences, values, and norms are assumed to be behind the concept of economic value. For example, the bare human survival requires a minimal set of economic necessities, survival then being a basic fundamental necessary value of human life. In an affluent society the urgency of survival moves into the background, and various needs for self-actualization move into the foreground. This requires an economic per capita surplus over and above a level of mere subsistence of human life.

Directly or indirectly economics deals with institutions and social groups such as consumers, producers, exporters, importers, investors, savers, and so on. It deals with economic power and hence political power. It deals with cooperation and conflict; for example that between labor and management. Clearly, economics has cultural and historic dimensions such as the evolution of capitalism versus socialism. Anthropology, demography, technological evolution and power politics are necessary for the understanding of the dynamic long-run economic developments and their differences: the "developing world" versus the "developed" world is a prime example.

As a reference to this outline, various aspects of economics and economic theory were discussed previously in the connection of the economic foundations of benefit-cost analysis.

Microeconomics deals primarily with the economic behavior of individual economic units such as "households" and firms", and then relates and aggregates upward to total economic behavior. An example of this would be the Walras-Pareto General Equilibrium model.

Macroeconomics deals with the economic behavior of social aggregates such as "industry", "consumers", "investors" and "government". Macroeconomics can have important institutional and political implications.

Economic development deals with spreading and growth of economic activity over time and space in the long-run. Typically, history, population dynamics, technological evolution and diffusion, power politics, geography of natural resources, and political geography -among others- are important dimensions of theories of economic development.

Institutional and historic economics deals with the social psychology and historic evolution of economic institutions and their interrelationships in accessing and utilizing economic resources. It is an essential dimension of political economics which examines political power relationships between social groups in their relations to accessing and controlling scarce economic resources.

5. POLITICAL SCIENCE

No one word or phrase can capture the many meanings of politics or of political science. With regard to politics, there are several guiding ideas or basic connotations. First, there is politics in the applied or "practical" sense that sees it as the "art of the possible". Emphasis here is upon obtaining mutual agreement among widely different sets of needs and attitudes, with the politician at the center of activity. This idea stresses politics as art rather than as science. The need to act takes precedence over the need to understand. A second fundamental meaning emphasizes the decisional aspect of politics. Decisions taken by and vested with the authority of the State are regarded as a process of social steering toward societal goals. A third approach sees politics

as power, coercion or force. Emphasized here is the idea of politics as control over the attitudes, behaviors and cognitions present within the social system. In international politics, military force is an obvious model for the exercise of power. The force conceptualization is emphasized also in the thinking of those who see the police as armies of occupation in ghetto communities. Fourth, there is the approach that emanates from the historic nexus of politics and economics in political economy. The principle of scarcity governs this approach, and politics is seen as the "authoritative allocation of values". This suggests a process of dividing among individuals the various economic and non-economic "somethings" that are important to them all, and of supporting this apportionment with the ultimate authority of the State. Its most useful expression is in the definition of politics as "who gets what, when, how?".

Turning to political science, we see again that no single definition suffices. It is obvious that the discipline should center on the study of politics, but disagreement exists as to whether the practice of politics will interfere with unbiased analysis. Again, while there is general agreement among political scientists to study public politics rather than allocations of values among private, non-governmental systems, there is disagreement about which aspects of private behavior are without public importance. Political scientists are also divided over the relative importance to be given to art, to systematic study, and the theoretically-directed science in examining core phenomena. This generally reflects the lingering effects of the traditionalist-versus-behavioralist controversies of the last twenty-five years.

In summary, political scientists are likely to investigate any phenomenon associated with government, decision-making, power, or the authoritative allocation of values. They may do so with empirical theory as a goal or as a guide--or they may pursue their work quite theoretically. The techniques of analysis to be used would include, among others, historical narrative, normative evaluation, legal research, or statistical and mathematical approaches. Some would say simply that political science is what political scientists do. This suggests an intellectual anarchy that denies the meaning of "discipline". Yet, it shows also the heterogeneity of subject and methodology that exists in the area today.

6. HUMAN GEOGRAPHY

Geography is a science which studies the location of human and physical phenomena on the earth's surface. It is a field of study which integrates both physical and cultural features in its quest to understand the relationship between man and his environment. Questions of where things are located, why they reveal specific locational patterns, and how they may be better located to serve man are central to the task of the geographer.

Human geography's primary orientation is with the social sciences. Unlike most social sciences it does not concentrate on a particular

social phenomena, but rather represents an integrated viewpoint of all social science phenomena. The nature of that viewpoint reflects both past and contemporary philosophical biases and assumptions.

Traditionally, geography has concentrated on the unique aspects of human phenomena in relation to their distribution and locations on the earth's surface. Regional geography, for example, represents this unique spatial viewpoint. Political, social, and economic phenomena have traditionally been studied from the perspective of their areal differences.

Contemporary geography represents a holistic viewpoint based on the premises of general systems theory. Under this viewpoint, the emphasis is placed on the interactions and distributional interfaces of social phenomena. The systematic approach concentrates on defining interconnections and functions of spatial systems. Among the major areas considered in the systematic approach are economic, political, social, and environmental subsystems. The spatial interrelationships between these systems provide the major thrusts to the analysis and the solution of problems having complex human and institutional interrelationships. Geography, functions in this sense, as a bridge within and among social and natural sciences. It is an integrative discipline which provides a comprehensive perspective not found in the more specialized social science areas.

Research orientations have demonstrated substantial shifts with the change from an areal difference approach to a systems or spatial interaction base. The initial emphasis in the systematic areas was on the geometric structure of space. Traditional location theory, for example, illustrated geometric orientation in space founded on partial equilibrium and normative models for the space economy. Included within this approach are the issues of defining optimal allocation patterns for spatial resources and resource imbalances on the earth's surface. The optimal location of manufacturing industries, service centers, resource management, and comprehensive regional and urban planning are central areas of concern under this approach. Coupled with this movement was a strong shift from qualitative approaches to computer based quantitative techniques.

More recently, the spatial interaction approach has experienced a shift from the earlier normative to a behavioral based orientation. Within this approach both overt and covert spatial behavior is of primary consideration. The approach stresses the notion of perception of objective reality and its associated behavior based on that perception. The geometry and locational structure of the earth's surface is studied as a series of cognitive or mental constructs. The behavioral approach represents a direction found throughout the social sciences and within the research of this contract becomes the primary point of interdisciplinary interfaces.

7. SUMMARY

The major thrust of this section is to provide a theoretical basis for inclusion of the social science impacts in a benefit-cost technology.

To avoid the potential biases of a too molecular approach, the inputs from all the social science approaches are considered. We will not try to summarize the content of each of the separate disciplines and subsequently integrate them in their existing forms. Rather, we will focus on the common ingredients of these disciplines. We will throughout the course of this work be introducing the kinds of things studied by sociology, anthropology, geography, economics and political science in an attempt to provide a basis for understanding real societies and subsequently relate them in a more advanced benefit-cost technology.

It is our opinion that existing approaches to benefit cost analysis suffer in that they have taken a molecular approach focusing too narrowly on the economic aspects of man's social life and excluding other relevant and critical components. The assumption underlying existing economically oriented benefit cost approaches is that economics provides an accurate view of man's social reality. Our position is that this assumption is highly unwarranted and that, in fact, the economic view is a highly distorted one.

IX. THE SYSTEM: A BASIS FOR INTERDISCIPLINARY INTEGRATION

Our first and primary focus is on the nature of man as an interactive being. That is, we will be studying person to person interactions as they occur in, and are affected by the environment. In this view we will be extrapolating those elements of human interaction which are common to all men. The taxonomic approach utilized in accomplishing this process is systems theory. Hence, our first task is to view man as an interacting system. Of necessity, this view is psychologically oriented. However, our focus is on those common human traits which are useful to social science. In addition to being psychologically oriented, our view utilizes the notions of systems theory. One of the reasons for the kind of molecular benefit-cost approach currently utilized is felt to be in the failure to include all levels of human social life and for providing a level of analysis or analytical model capable of addressing both the relatedness and complexity of that social organization. Systems theory provides just such a model.

We are not going to delve deeply into the implications of the systems approach except to say the focus is on an open system. In light of the previous discussions of micro and macroeconomic approaches and especially of the handling of "externalities", such an open systems view is critical since it allows for the consideration of such externalities.

1. SOCIAL MAN

Social man is unique in that he is the product of unlearned and learned aspects. Initially, there is a biological being with capacities

and equipment which allow him to interact with his environment. Hence, to know something of man demands knowledge of his creation, his major parts, and how these parts relate overall. Additionally, since man also has learned capacities, this view demands knowledge of the interaction process. What is the effect of the environment on this process; what does man do; where does he go; how does he interact with other human beings?

The answers to this first set of questions will be treated as intra-system aspects of human nature; the latter as intersystem aspects.

In presenting a model of social man we will closely follow the work of Alfred Kuhn who has treated man from an intrasystems perspective. In this view he sees man as, "a highly developed self-preserving system, with a self-organizing, high capacity information processing center in the brain. A self-preserving system is one that so adapts to its environment as to increase significantly its chances of surviving. The high-capacity information processing means that man can engage in complex, varied, and sometimes highly roundabout adaptations, which we can also describe as creative and imaginative". [167]

Kuhn sees this ability to give creative and imaginative responses as the basis for man's adaptivity. The notion of adaptivity is important in that it points to a kind of tough persistence to survive under widely different environmental conditions.

This adaptive behavior means the organism responds differently to different circumstances. Such adaptation is generally oriented toward "successful adaptation" which means the system is in some way better off. However, at times systems do engage in dysfunctional adaptations. From the point of view of man as system, Kuhn proposes three necessary ingredients: "...a system, giving a response, in and to its environment. To put the three in the simplest order of occurrence, (1) the environment (2) acts on the system, (3) which engages in adaptive behavior....In the language of the controlled, or adaptive, system these functions are performed respectively by the detector, the selector, and the effector." [167]

In an operational sense this system may be diagrammed as on the following page. While this model is basic to all controlled systems, the model of social man is considerably more complex. For example, in the human being there is a maintenance system concerned with the biological functions, such as, eating, drinking and sleeping. While this system is important, especially to the biologist, the social scientist is more traditionally concerned with what Kuhn calls the control system since it is this system which does the actual guiding, directing or controlling of the controlled system. To this controlling system, Kuhn gives the label the behavioral systems. [167]

The next important consideration for understanding social man is what are the inborn components of the system? It appears that there are no inborn components of significance for directed behavior in human beings. This means that all social behavior is learned behavior. A second major aspect of the inborn components of man is that he does not inherit patterns of explicit behavior, but rather, inherits behavior-selecting

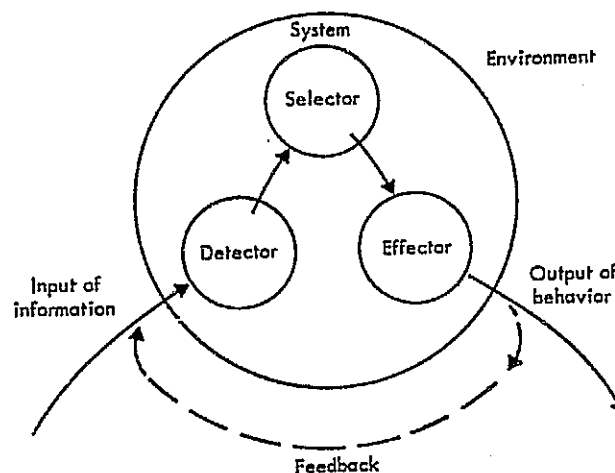


Figure 31. Diagram of the DSE Subsystem of Any Controlled System [167]

mechanisms usually in the form of preferences, e.g., pain avoidance. A succinct summary of the inborn components of the detector, selector, and effector aspects of man are presented in Kuhn's summary table on page 198, Figure 33.

The complexity of social man as a system is much more evident when each of the detector, selector and effector subsystems are viewed. Kuhn notes that each of these subsystems are functions and that the detector function deals with how man knows about his physical environment, other people, himself. He points out that this function deals with what is, and not what is preferred. Two major problems are presented to humans in this regard: (1) creation of models that correspond in useful ways with some aspects of reality and (2) learning the rules of identification by which one reliably relates the parts of reality to the parts of the model. This process has been treated by psychologists as a cognitive mapping process. This process can be further refined in terms of the imaging process, patterning of the images, and so forth. However, we will not delve into these aspects as they are not necessary to our purpose. However, it should be noted that these processes are important and fundamental for social science. The vast majority of images in people's heads are learned from society. Hence, since you cannot perceive something in your environment unless an image of it has already been learned and stored in our head [167] it means that, for the most part, a person perceives only those aspects or conditions of society that the society has taught them to perceive.

In considering the selector component of the social man system, Kuhn notes that the major components consist of the primary motives and with the learned components of selector or the secondary motives. In Kuhn's model the primary motives consist of pleasant or unpleasant valences that are activated by selective sensations and emotions. The "secondary motives consist of a conditional connection between a valence and a concept — the learned motive is a concept (image) with a valence attached" [167]. The process of acquiring these motives (pattern learning) involves both (1) learning the image in the detector and (2) attaching a valence to it in the selector.

In the present benefit-cost model this aspect of the social man system is the locus of the preference structure. In this sense, we use learned patterns of likes and dislikes whenever we make choices that reflect them.

The effector is the process of translating the preferences into actual performance. This translation involves the motor responses or actual behavior.

The next task in terms of completing the model is to examine the interrelations among the detector, selector and effector components. Kuhn notes that one of the more important aspects of these interrelations is that the learned aspects of selector and effector depend on the detector. However, the three components also modify one another. Kuhn illustrates this via the following example of modification of detector by selector. "We often see what we want to see, hear what we want to hear, and believe what we want to believe, despite evidence to the contrary." [167]

Another notion of system theory that contributes more complete understanding to the social man system is that almost all systems have some optimum level of operation. Below that level it is relatively inefficient and above the level it comes under strain. In the human system Kuhn defines self-actualization as the sense of satisfaction resulting from optimal operation. In terms of the three subsystems this means formation of patterns in the detector; derivation of satisfaction in the selector; and, acquisition of rewards in the effector.

When one takes into account the interrelationship between the subsystems the processual character of self-actualization is seen. That is, one of the consequences of externalizing the inner patterns is that we observe them and consider them and in this sense, they modify the original state.

The final step in completing this systems view of man is accomplished by Kuhn through introduction of main level and sub-level detector, selector and effector components. That is, within each of these components, Kuhn introduces a sub-detector, sub-selector, and sub-effector. Kuhn's following model illustrates this process.

In this expanded system "the effectiveness of the whole system can be analyzed in terms of the effectiveness of its three subsystems, taken separately and jointly" [167]. The following outline summarizes the total model.

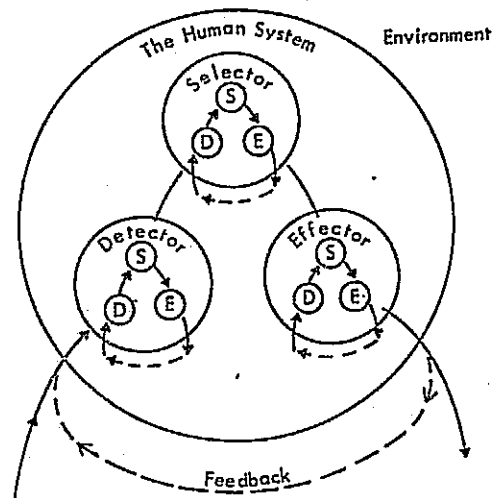


Figure 32. The Behavioral System in an Environment
(including DSE subsystems) [167]

The various aspects of this model of social man deal with the nature and direction of behavior. It also provides a basis for assessing the magnitude of its effect which Kuhn calls power. "The amount of one's power depends on how well he sizes up the situations he must deal with (detector), how strongly he is motivated (selector), and how skilled he is at producing results (effector), along with the conditions in the environment that assist or provide obstacles to achievement" [167].

	Unlearned, Inborn Components	Learned Components	
		Pattern Learning	Pattern Using
Detector	<p><u>Sensations (primary information)</u></p> <p>On an inborn basis, light, sound, odors, tastes, pressure, heat, etc. actuate different nerves and enter the brain through different channels.</p>	<p><u>Concept Formation and Attainment</u></p> <p>(<u>learning secondary information</u>) (induction)</p> <p>The brain organizes sensory inputs into patterns and patterns of patterns. Image learning and testing.</p>	<p><u>Perception (Deduction)</u></p> <p>Sensation currently received serve as ones which identify already learned patterns. Image using and identification (detecting plus decoding).</p>
Selector	<p><u>Valences (Primary Motives)</u></p> <p>On an inborn basis certain tastes, odors, and other sensations are pleasant, others unpleasant. These sensations, along with some emotions, guide the learning of more complex approach or avoidance behaviors.</p>	<p><u>Secondary Motives</u></p> <p>The brain connects the inborn valences to new or different sensory inputs, and to concepts.</p>	<p><u>Making Choices</u></p> <p>Choices are made on the basis of secondary motives, which are mostly valenced concepts.</p>
Effector	<p><u>Motor Connections</u></p> <p>Each muscle has an inborn connection to a particular point in the brain, so that different muscles are actuated by different channels from the brain.</p>	<p><u>Motor Skills</u></p> <p>Through practice the brain connects muscle responses into groups and sequences that constitute performance skills.</p>	<p><u>Motor Performance</u></p> <p>Motor skills already learned are executed.</p>

Figure 33. Outline of the Model of Man [167]

2. OTHER LEVELS IN THE SYSTEM

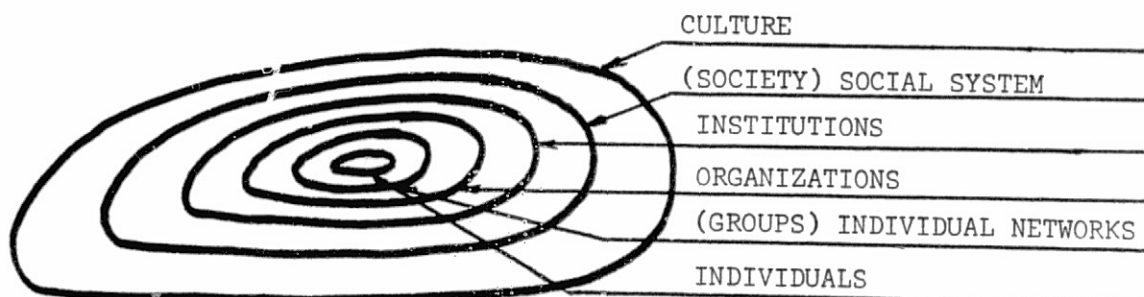
Now that a basis has been laid for viewing man from a systems perspective, the next task is to determine how he is integrated into a society. In this view both a person and a society of persons are acting systems. The society is defined as any group of people having the same body and process of culture.

This definition by Kuhn does not specify its size and he further notes that depending on circumstances, as few as two and as many as the human race could be a society [167]. That is, any set of people who tend to develop some degree of consensus can be viewed and analyzed as a society. However, this process definition doesn't bring out some of the more traditional sociological notions associated with a society. Most sociologists agree that the crucial criteria involved in creation of a society are: (1) relative self-sufficiency, (2) continuity of existence from generation to generation, and (3) relatively large size. In this sense, a society is a social group that manages to meet most of its own needs, maintains a system of social interaction across generations, and has a discernible internal organization. Aberle and others argued in an article on the functional prerequisites of a society that nine aspects are involved including; (1) provision for adequate relationship to the environment and for sexual recruitment, (2) role differentiation and role assignment, (3) a system of communication, (4) shared cognitive orientations, (5) a shared, articulated set of goals, (6) prescription of the means for attaining the socially formulated goals, (7) the regulations of affective expression, (8) a system of socialization, and (9) effective means for controlling disruptive forms of behavior.

While a definition based on these prerequisites would appear to be perhaps one of the broadest units of social organization, this is not the case. Culture is an even broader concept. It is also a more difficult concept to define. Early definitions, for example, that of Edward Tylor, stressed culture as a complex whole. This complex whole included knowledge, belief, art, morals, custom, and any other capabilities and habits acquired by man as a member of society. Since this time, however, several other definitions have emerged each stressing a slightly different fact, for example, many saw culture as social heritage, still others as norms, or adaptive mechanisms. In any case, it is generally considered to be a broader concept than societies.

In order to help clarify this issue further the following diagram is offered. In this view, culture is seen as the broadest principle of organization of the human race. Each of the smaller inner circles represents a smaller unit of organization. Hence, it is possible for more than one social system or society to share in many aspects of culture and yet remain as a distinct society. Institutions are somewhat smaller units of organization though many argue that institutions, such as the family, are common to all cultures. We do not deny this, but rather point to the fact that it involves less of man's total social reality than does

either culture or society. This same principle of organization is held for all the other remaining circles. Perhaps, however, the following example will be helpful. Education is an American institution, while the University of Notre Dame is an organization within the larger educational institution.



To this point we have discussed the individual and now briefly society (without including the social systems notions) and culture. The remainder of this section is devoted to discussing institutions, organizations, and individual interactive networks. However, a good understanding of institutional behavior is felt to be dependent on a better understanding between social structure and institutions. In the development of the notion of social structure sociologists initially focused on the biological structure and created an organic analogy in terms of social relationships. These analogies while giving insight into the structure of society did not provide the kind of precise conceptualization needed to understand complex social relationships. In attempting to provide a more precise meaning Radcliffe-Brown defined the social structure as including all person to person relationships [168]. Examination of concrete social reality in this conception is concerned with examining the set of actually existing relationships at a given time which link persons to each other in an organized manner. The general aim of this approach is to determine and analyze the structural form of these relationships. Critics have noted that such a conception fails to discriminate between transitory short-range relationships and the more enduring elements of social action.

Other scientists have tried to make this definition more permanent by introducing the notions of groups and institutions which constitute a society. This approach is at one and the same time abstract and concrete. By observing social groups one derives the concrete basis of social action. The abstract part of this approach inheres in the process of examining institutional arrangements or other intergroup relational processes. Among the scientists espousing this procedure is Raymond Firth [169] who proposes restricting the term social structure to refer to the more permanent and important social activities. In his view the term social organization means the systematic ordering of social relations by acts of choice and decision. This view is felt to account for the

continuity principle in a society while the organizational level is felt to account for the variation or change principle.

Another way of looking at social structure is by introducing the notion of a social role. S. Nadel, in addressing this conception focuses on the population and abstracting there from the patterns of regularized behavior. The result of this view is social structure viewed as a network or system of relationships existing between actors. Gerth and Mills [170] use role as a central notion in their definition of institution. Roles are the primary building units in institutions, while institutions are the primary building blocks of social structure. There is considerable discussion within the field of Sociology as to whether introduction of the notion "role" doesn't make the study of social structures too individualistic. These scientists propose that social groups within a society should be the basic building blocks. Perhaps, however, no one has summarized the problem more accurately than T. B. Bottomore [166] who in discussing the various theories of social structure notes:

"Of the different conceptions...the most useful seems to me that which regards social structure as the complex of the major institutions and groups in society. There is no great difficulty in identifying these institutions and groups. It can be shown that the existence of human society requires certain arrangement or processes; or, as has been said, that there are 'functional prerequisites of a society'" [166].

The relative ease of identification Bottomore speaks about with respect to identifying the institutions is felt to lie in the fact that institutions center around basic social functions such as marriage, government, or education. The institutions provide social norms which give direction to human behavior through provision of proscribed forms of activities. In this sense, they consist of an enduring complex of integrated and organized behavioral patterns through which social control is exerted and by means of which the fundamental desires or needs are met.

The most striking difference noted when movement is made from the wider institutional circle to the smaller organizational circle is that organizations are less encompassing in terms of human involvement. That is, the institutional level prescribes a set of values and relationships addressed to all people who operate within the institution. The organization on the other hand, is more specifically oriented toward structuring aspects of these institutional requirements in relation to a particular set of goals. For example, health is an institution in American society. The delivery of health is accomplished through public health officials, nurses, M.D.'s, Osteopathic Physicians, Chiropractors, faith healers, clinics, hospitals, etc. Using the hospital as an example, the study of its social organization would include the functioning of a particular hospital (organization) and the ways in which various aspects of the institutional structure, such as the hierarchical ordering of the staff, maintains this structure. Within this structure there are certain rules of conduct which are understood by all members of the organization and are maintained through various means. Perhaps the most basic aspect of social organization is a common understanding among

members of the organization as to the interpretation of certain aspects of social reality. This may be illustrated through the same hospital example. For instance, within the hospital there usually exists, within broad limits, a shared understanding among the staff as to how the reality of certain situations, such as deaths, different kinds of operations, and other crises and everyday activities, are to be thought of. There will also be an unstated agreement as to what action is called for relative to these situations, and inappropriate action will immediately be recognized as such. The greatest portion of man's life is lived within such structural arrangements.

The next smaller circle is labeled interactive networks. The major difference at this level is that the degree of structure is considerably less than that found at the organizational level. In this sense, there is some resemblance to groups. However, the following differences do pertain. The interactive networks are concerned with the wide number of structures and the way the individual is integrated in them. This level is seen as an important one since it helps to determine the individuals interpretation of social reality. From a personality perspective, the influences of the interactive networks are important involving such processes as, identification, imitation, modeling, consciousness of kind, reference concepts, the development of learned and moral concepts. In addition, the content of the socialization process is to a great extent conditioned by the networks. That is, the values, the norms, the roles, and type identity acquired, are pretty much affected by exposure to the interactive network.

The next question to be answered, therefore, is, what do all these levels of organization have in common? The most obvious answer is that people are involved at all levels. Hence, the question becomes; what is similar in the way people relate or are integrated into the various levels of social organization? The answer to this question is found in a body of theory called, "social action theory".

3. A THEORY OF SOCIAL ACTION

After reviewing several approaches to a general theory of social action, the work of Smelser [171] has been selected for providing a basic guideline. This selection is based on the fact that he has created the approach by summarizing the works of Parsons [172], Shils [173], Bales [174] and indirectly through these works he has incorporated the ideas of Pareto [175].

The collective efforts of these persons has led to the following definition of social action:

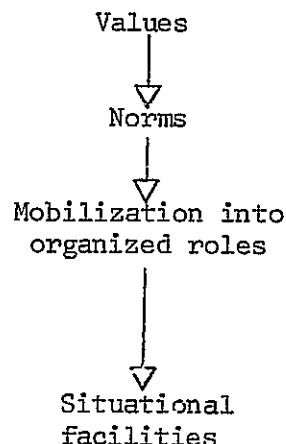
[The theory of action] conceives of [the behavior of living organisms] as oriented to the attainment of ends in situations, by means of the normatively regulated expenditure of energy. There are four points to be noted in this conceptual-

ization of behavior: (1) Behavior is oriented to the attainment of ends or goals or other anticipated states of affairs. (2) It takes place in situations. (3) It is normatively regulated. (4) It involves expenditure of energy or effort in "motivation" (which may be more or less organized independently of its involvement in action) [171].

This leads Smelser to conclude that certain basic elements must be known prior to the description of action. These are referred to as the four basic components of social action and include the following:

(1) the generalized ends, or values, which provide the broadest guides to purposive social behavior; (2) the regulatory rules governing the pursuit of these goals, rules which are to be found in norms; (3) the mobilization of individual energy to achieve the defined ends within the normative framework. If we consider the individual person as actor, we ask how he is motivated; if we move to the social-system level, we ask how motivated individuals are organized into roles and organizations; (4) the available situational facilities which the actor utilizes as means; these include knowledge of the environment, predictability of consequences of action, and tools and skills [171].

There is, of course, a relationship between the components of social action - a hierarchical relationship which is illustrated in the following diagram.



In this scheme values are seen as "standards of desirability" (desirable end states) and hence are "general guides to action". In this sense they are not very specific. However, as they are incorporated into human behavior in a social action sense, they must be both narrowed and regularized. (To the extent this process occurs, they also provide a greater degree of predictability.) This regularization is accomplished in the patterning and institutionalizing of the values at the normative level. The fitting of humans into the organized sequence occurs at the

next level - mobilization of energies. The subsequent expression of this organization is found at the lowest level - situational facilities. This level is viewed as a resource level.

The operation of humans within such a scheme is well summed in a statement by Harold Lasswell: "Men seek values through institutions utilizing resources." [176] In other words, the institutions in a social group are a reflection of the value system of that group. However, there are some problems with this axiom which are discussed in a later section.

There are also some other important relationships between the components of social action which must be noted. For example, as movement is made progressively from values to situational facilities there is both an increasing specification of the value and a proliferation of applications of the same value. Smelser [171] notes that this movement expands so as to include components of action which are progressively less central to the integration of the social order. He also notes that there is a one way influence relationship among the components of social action which has important consequences for social change. That is, if you alter a value, then change is introduced all the way down through situational facilities. However, a change at a lower level doesn't necessarily affect the higher levels.

Smelser [171] also notes that complete understanding of a theory of social action is dependent on determining not only the relationship between the components of social action but within each component. We have already discussed the "between" aspects of this scheme. In accomplishing the within analysis, Smelser addresses seven specific levels at which each of the components of social action can be viewed and assessed. Once again, there is a diffusion and specificity function incorporated. That is, as one moves from the most general level to the least general level the component of social action becomes progressively more specific and circumscribed. Table 7 from Smelser's [171] work is included in its entirety to help illustrate this process for all four components of social action. However, the following narrative is also offered in order to help clarify the table (see next page).

Values are used in presenting this narrative. At their most general level values are the major premises of social order in that they set ends or goals and legitimize them by a particular view of man, nature, and society. At this level the value system is contained in the general belief system of all humans. The translation of these generalized beliefs (values) into social action begins at the second level wherein they are specified in relation to the different institutional sectors of a society. The third level specifies what kinds of activities and rewards are to be legitimately pursued within these institutional sectors. Thus, it becomes evident that as we move toward the more specific levels we learn more about how the value applies in a definite social context. On the other hand, moving from the more to the less specific, we learn what the bases of legitimacy are for these lower level specifications.

TABLE 7

LEVELS OF SPECIFICITY OF THE COMPONENTS OF SOCIAL ACTION

More specific	Level	Values	Norms	Mobilization of motivation for organized action	Situational facilities
	1	Societal values	General conformity	Socialized motivation	Preconceptions concerning causality
	2	Legitimization of values for institutionalized sectors	Specification of norms according to institutional sectors	Generalized performance capacity	Codification of knowledge
	3	Legitimization of rewards	Specification of norms according to types of roles and organizations	Trained capacity	Technology of specification of knowledge in situational terms
	4	Legitimization of individual commitment	Specification of requirements for individual observation of norms	Transition to adult-role assumption	Procurement of wealth, power, or prestige to activate Level 3
	5	Legitimization of competing values	Specification of norms of competing institutional sectors	Allocation to sector of society	Allocation of effective technology to sector of society
	6	Legitimization of values for realizing organizational roles	Specification of rules of cooperation and coordination within organization	Allocation to specific roles or organizations	Allocation of effective technology to roles or organization
	7	Legitimization of values for expenditure of effort	Specification of schedules and programs to regulate activity	Allocation to roles and tasks within organization	Allocation of facilities within organization to attain concrete goals
More specific					

The fourth level specifies what is appropriate in terms of the kind of commitment for the individual actor at the role level, while the fifth limits the scope of a given value activity by viewing it in relation to competing values which must also be respected. At the sixth level the values specify the kinds of commitments that are necessary at the operative level if the organizational ends (end state values) are to be realized. Finally, at the seventh level, there is the personal commitment to implement the higher level values of the organization. [171]

A similar procedure is followed by Smelser for outlining all four components of social action and while complete and detailed understanding demands such detail, it is felt that the scheme can be greatly simplified without sacrificing overall comprehension. The first step in accomplishing this simplification is found in reduction of the number of levels in the following manner. Smelser notes that levels one through four are concerned with very general commitments to values while levels five through seven redefine or restrict the meaning within specific organizational contexts or operations. We prefer to refer to the general levels (1 through 4) as the axiomatic level and those at the specific levels as integrative operatives. By axiomatic values, for example, we mean those values which tend to be universally recognized and accepted as self-evident or true and do not require proof. For example, that all human beings have the right to be. The integrated operative values refer to those which govern specific operations associated with man's day to day activities.

The reduction from seven to two levels produces the following consequences for the theory of social action. In the realm of values those general societal values including the legitimization of institutions, rewards and individual commitment are now contained in level one (axiomatic values). Level 2 contains the legitimization of competing values, organizational ends, and personal expenditure of effort in the realization of ends. The norms component of social action is roughly divided into those norms circumscribing activity in the various sectors of society (Level 1) and those guiding activities at the institutional level (Level 2). The third component of social action, mobilizing motivation for organized action addresses the socialization process concerned with general social participation at level one and the mobilization of particular motives associated with activities in individual organization (Level 2). Finally, the fourth component reduces to a generalized belief regarding the distribution of resources as they affect society (Level 1) and the allocation of resources to specific sectors and institutions in society (Level 2). The major effect of this reduction is the creation of a manageable scheme without sacrificing the essence of the hierarchical arrangement necessary to a complete understanding of the individual components.

4. THE SOCIAL SYSTEM: INTEGRATING PEOPLE AND SOCIAL STRUCTURE

The goal of this section of the presentation on social sciences has presented an integrated view of man and provides a better basis for understanding his social behavior. To this end we have presented a model of man as social being. We further noted that man's behavior is oriented toward values which he seeks through organized behavior (institutions) utilizing the resources he can command. This organizational process was shown to involve many levels and yet man's participation in each of these organizational levels is governed by common elements which were discussed as the elements of social action (values, norms, mobilization of motivation, and resource utilization).

Our next task is to discuss the level of organization at which all these elements coalesce into patterned activity oriented toward preservation of the social group. This level is referred to as the social system. While several authors have written on social systems our presentation will revolve primarily around the works of Pareto [175] and Parsons [172].

In Pareto's view the concern was with predicting the form a society takes and in discovering the forces and principles operating which help determine that form. He saw this study as involving a better understanding the common hard-core sentiments which persist in a society under a variety of forms. These sentiments as manifested in what Pareto called residues are complemented by appetites and inclinations. However, to understand the full implication of Pareto's work one must view the multitude of elements which comprise his theory. These elements are grouped into four principal categories.

- "1. Interests. These are largely the logical, goal-oriented elements of conduct that provide the basic data for the science of economics.
2. Social heterogeneity and circulation. Today we might refer to this category as 'class dynamics'. Broadly speaking, it is concerned with social stratification and mobility, but Pareto deals with it in terms simplified enough to permit him to specify the basic mechanisms of equilibrium in the political structure.
3. Derivations. Pareto lists seventeen derivations, which he groups in four classes. (These appear in Appendix L.) They are the verbal utterances, assertions, appeals to authority, and rationalizations that represent man's hunger for logical explanations of his actions. However, given the overbearing force of 'sentiments' (the non-logical, unpremeditated, self-acting, moral forces of human behavior), the explanations in fact turn out to be mostly pseudo-logical.
4. Residues. Of these Pareto enumerates a total of fifty-one basic ones, which he organizes into six classes. They are the manifestations of the fundamental action predispositions of men, that is, the sentiments or underlying forces of human conduct." [175]

In determining the course of human action within his scheme Pareto concludes that social scientists have gone astray by failing to distinguish between the logical and non-logical bases of conduct. This conduct is a function of a constant non-logical element and a deductive element designed to explain, justify and demonstrate the constant element. It is the non-logical conduct which is given credit by Pareto for the major part of man's social relationships. He sees human laws as being deduced from certain principles of non-logical conduct. These principles of non-logical conduct are correlated with the conditions under which humans live and change. As for the importance of the rational element in this scheme Pareto sees reasoning as having;

"...so little force as motive power that one might also say it must be changed into sentiment in order effectively to determine conduct. Behavior (B) depends upon the unknown psychic state (A) but is justified by a theory (C), which is usually not strictly logical in its connection with (B). Magic in the ancient and Christian eras provides many examples of entirely non-logical action, for which sometimes theological, sometimes logico-experimental, explanations are provided. Such examples show a kernel of acts and words more or less constant, while the logical interpretations tacked on to them are quite secondary and change with fads in thinking." [175]

The conclusion Pareto arrives at with respect to human conduct is that it can either be logical (rational), using means appropriate to ends, or non-logical (irrational) inappropriate means-end relationship. He considers the non-logical conduct to be more important from the objective viewpoint of determining the form of human society and its development.

In this distinction a constant and variable part of Pareto's theory is evident. The variable part, which comprises the detailed methods used and the reasons advanced for their use, he terms "derivations". The constant part he calls "residues".

RESIDUES

This most important aspect of Pareto's theory is, in his formulation, the forces which explain social equilibrium. Pareto discusses fifty some residues but they all fall into six classes. These classes are as follows:

- " I. Residues of combinations (889-990) 12.
- II. Residues of Persistence of aggregates (991-1088)
- III. Residues (or needs) of the manifestation of sentiments through overt acts (1089-1112)
- IV. Residues in regard to sociability (1113-1206)
- V. Residues of the integrity of the individual (1207-1323)
- VI. Sexual Residues (1324-96)

While the strength and proportions of these residues vary from time to time and from social group to social group, they are the constant elements of any social system." [175]

A proper understanding of just what residues are, is essential to a correct understanding of Pareto's theory. He warns that we should be-ware of ascribing any objective existence to residues or even to sentiments. For what is observed in reality is a group of human beings in a mental condition indicated by what is called sentiments. In a further clarification Pareto states the proposition, "that the sentiments manifested by residues are among the elements which stand toward the social equilibrium in a relationship of reciprocal determination." He further clarifies this in the following manner. "The mental states that are indicated by the sentiments expressed in residues...." However, even further clarification is needed, for what are the "mental states?" His answer is, "they are abstractions." This in turn obliges us to say:

"The actions of human beings are among the elements that stand in a relationship of reciprocal determination with the social equilibrium. Among such actions are certain manifestations that we designate by the term 'residues' and which are closely correlated with other acts so that once we know the residues we may, under certain circumstances, know the actions. Therefore we shall say that residues are among the elements that stand in a relation of reciprocal determination with the social equilibrium." [175]

Each of the residues point to an important element in the total social system and in the organization of human behavior and, as such, are discussed class by class.

The first class is the instinct for combinations. Basically, Pareto feels, there is an instinct that prompts combinations in general, for reasons which are fleeting, momentary and undetectable. He uses the scientist and the ignorant person to point out the logical and non-logical aspects of combination.

"The scientist in his laboratory makes combinations according to certain norms, certain hypotheses, for the most part rational (at times he combines at random). His activity is primarily logical. The ignorant person makes combinations in view of analogies that are mostly fantastic, absurd, childish (and often by chance). In any event they are in large part non-logical acts." [175]

It is this non-logical aspect that brings about the reasons for Pareto's reference to an "instinct" for combination and which later leads him to conclude that most human action is non-logical. Pareto also states that similar things are more often combined than opposites and that human beings feel a need for combining various residues. What is most interestingly noted by Pareto is that there is a more keenly felt need among higher civilized people to cloak acts that are in themselves non-logical with a logical veneer.

In summary, then, the first class results in our combining certain things, usually similar. One also notes a search for the combinations that are deemed best and a propensity to believe that they actually do what is expected of them.

Class II. Residues for the persistence of Aggregates. This includes any manifestation of a tendency to preserve social relationships. It implies that,

"...by a sort of inertia, aggregates once constituted or personified tend to persist...attempts at their disunion encounter powerful opposition. All the survival of customs persisting after their causes have disappeared illustrate residues of this class, as does the persecution of sexual 'heretics', which is a manifestation of attitudes similar to those of the Inquisition ...Even abstractions like progress, socialism, or pacificism are dynamic aggregates, lacking only personification. As the residues of Class I may be said to account for innovation, so the residues of Class II account for conservation of things as they are." [175]

If it were not for the persistence found in Class II then the combinations in Class I would be mostly ephemeral. It should also be noted that these first two classes seem to be the most important in Pareto's theory.

Class III. Need for expressing sentiments by external action. Pareto enters very closely into the field of psychology in this class. He states;

"Powerful sentiments are for the most part accompanied by certain acts that may have no direct relation to the sentiments but do satisfy a need for action. Something similar is observable in animals. A cat moves its jaws at the sight of a bird; the dog twists and turns and wags its tail at sight of its master; the parrot flaps its wings.

Says Lyall further: 'The present writer knew a hindu...who devoted several hours daily to the elaborate worship of five round pebbles which he had appointed to be his symbol of Omnipotence...' Notable in that is not merely the need for the symbol, but the need for 'doing something'...

...It may be further evidenced that the residues of this class stand conjoined with emotions, sentiments and passions in complex concatenation of actions and reactions." [175]

Class IV is made up of residues connected with life in society. Pareto observed that, with the exception of the cat, all domestic animals live in groups. He also includes disciplinary residues in this class and sees them as indispensable to society. This may best be seen in man's social conduct.

"The conduct to which they lead may be seen in the necessity of being just like everybody else which a style imposes and in every sort of standardization, making individuals take the mold of some social group, large or small, to which they belong. Pity and cruelty and nephobia or the fear of innovations as upsetting established uniformity, are discussed in this connection. One of the most interesting subdivisions is asceticism, a sort of renunciation characterized by great intensity and slight social utility and found far beyond the limits of medieval Christianity, for Christian doctrine is only one of the (plausible) derivations employed to give a color of reasonableness to this class of residues." [175]

Class V is entitled, Integrity of the individual and his appurtenances and possessions. Pareto finds this class as complimentary to Class IV.

The first illustration Pareto presents follows:

"To defend one's own things and strive to increase their quantity are two operations that frequently merge. So defense of integrity and development of personality are two operations that may differ little or even be one and the same..." [175]

Thus it is also Class V that manifests those sentiments opposed to alteration of the social equilibrium. He uses the terms "just" and "unjust" to illustrate a maintenance or disturbance of social equilibrium. And the residue or kernel of the restorative act is the Integrity of the individual.

Class VI is the sex residue. Pareto is not concerned here with mere sexual appetite but rather with its influence upon theories and modes of thinking as a residue. In respect to this residue, there comes into play many combinations as the residues unite in complex forms. An example of this is the union of asceticism with the sexual residue which produces a "sexual religion", with taboos that are never observed and which in their rigidity serve to generate perversion and hypocrisy. [175]

Pareto lists no specific subdivisions under the sex residue and it is generally assumed he would include anything that could be considered a manifestation of sex.

It should be noted that it is precisely in the varying strength of residues that Pareto finds the explanation of movements of social phenomena. He points out that the residues of Class I vary little and slowly, those of Class V scarcely at all, while some of the subgenera vary considerably. From this it can be derived that the best index of the social state of a people is the proportion of the various classes of residues. [175]

DERIVATIONS

According to Pareto the residues just discussed are verbally rationalized, and such verbal rationalizations of residues he denoted as derivations.

"A derivation, he said, is a failure to use means appropriate to ends. It is a nonlogical argument, explanation, assertion, verbal proof, or appeal to authority, in accord with the sentiments. Under the category of these irrational 'derivations' he examined historical and contemporary philosophies, ideologies, theories, ethical discussions, and religious ideas." [175]

The derivations are considerations from a "subjective" standpoint, that is, in human action the main persuasion is accorded by residues, which are the objective forces, while the derivations are the subjective colorations of the residues.

He considers human actions as being influenced by derivations and that these derivations are accepted or rejected by what the person imagines to be logico-experimental grounds.

"He does not notice that he ordinarily makes up his mind in deference to sentiments and that the accord (or conflict) of two derivations is an accord (or conflict) of residues. When, then, a person sets out to study social phenomena, he halts at manifestations of social activity, that is to say, at derivations, and does not carry his inquiry into the causes of activity, that is to say, into residues." [175]

Pareto notes that derivations are things that everybody uses. But he notes that many of the contemporary writers of his day ascribe an intrinsic value to derivations and regard them as functioning directly as determinants of the social equilibrium. Pareto, on the other hand, sees them only as manifestations, as indications, of other forces that are the forces which really determine the social equilibrium.

Several extremely important insights are provided by this view of the social system. Initially, Pareto points to the role of beliefs or sentiments in governing man's view of and subsequent action in the social system. He points to the fact that man tends to maximize his behavior in relation to these sentiments which may have no relationship to the realities involved. At the same time, however, Pareto sees man as needing a "logical" or "rational" explanation for such behavior to cover over or justify his position. He presents a listing of seventeen such justifications or rationalizations. At this point we would like to interject the notion that traditional benefit-cost analyses for the most part constitute one such elaborate attempt to explain, justify and often rationalize a position which is either out of line with the real needs of man or serves the vested interests of a subgroup of persons.

Pareto also concludes that there are indeed behavioral manifestations of the real underlying sentiments or action predispositions of man. Hence, prediction of man's social behavior lies in ascertaining the direction and forces of the sentiments as they are expressed in his behavior. In this regard, Pareto has also furnished us with an important insight into man's social behavior — the persistence of aggregates. Once man groups form and "sentiments" with "explanations" to justify them are attached, they tend to persist and act as determinants of man's social behavior. As we shall be noting later on, the predictability of man's behavior is contained in this very propensity. That is, man is socialized into this position and he by nature tends to over conform to these sentiments and the "explanations" thereof.

Another view of the social system is presented by Talcott Parsons. This view is important to the social science study of man because it focuses more clearly on the functional aspects of the system and on the processes articulating those subsystems.

5. PARSONS' VIEW OF THE SOCIAL SYSTEM

The social system, personality system and the cultural systems are all part and parcel of the object world according to Parsons. Thus, to truly start to assess the impacts of new innovations in a society one would have to concentrate on all three aspects of the object world. In the present systematization of a benefit-cost approach, all these elements of the object world are included. However, the primary focus is on the social system. This view is felt to be quite important in that it provides further clarification of the complex aspects involved. That is, the social systems model focuses attention on the four major subsystems comprising any social system. Further, it directs attention to the communications processes articulating those systems. Thus, the purpose of this view is to elucidate those areas or subsystems in which social action is involved. In this model by Parsons there are four major subsystems including the adaptive, goal attainment, integrative, and pattern maintenance.

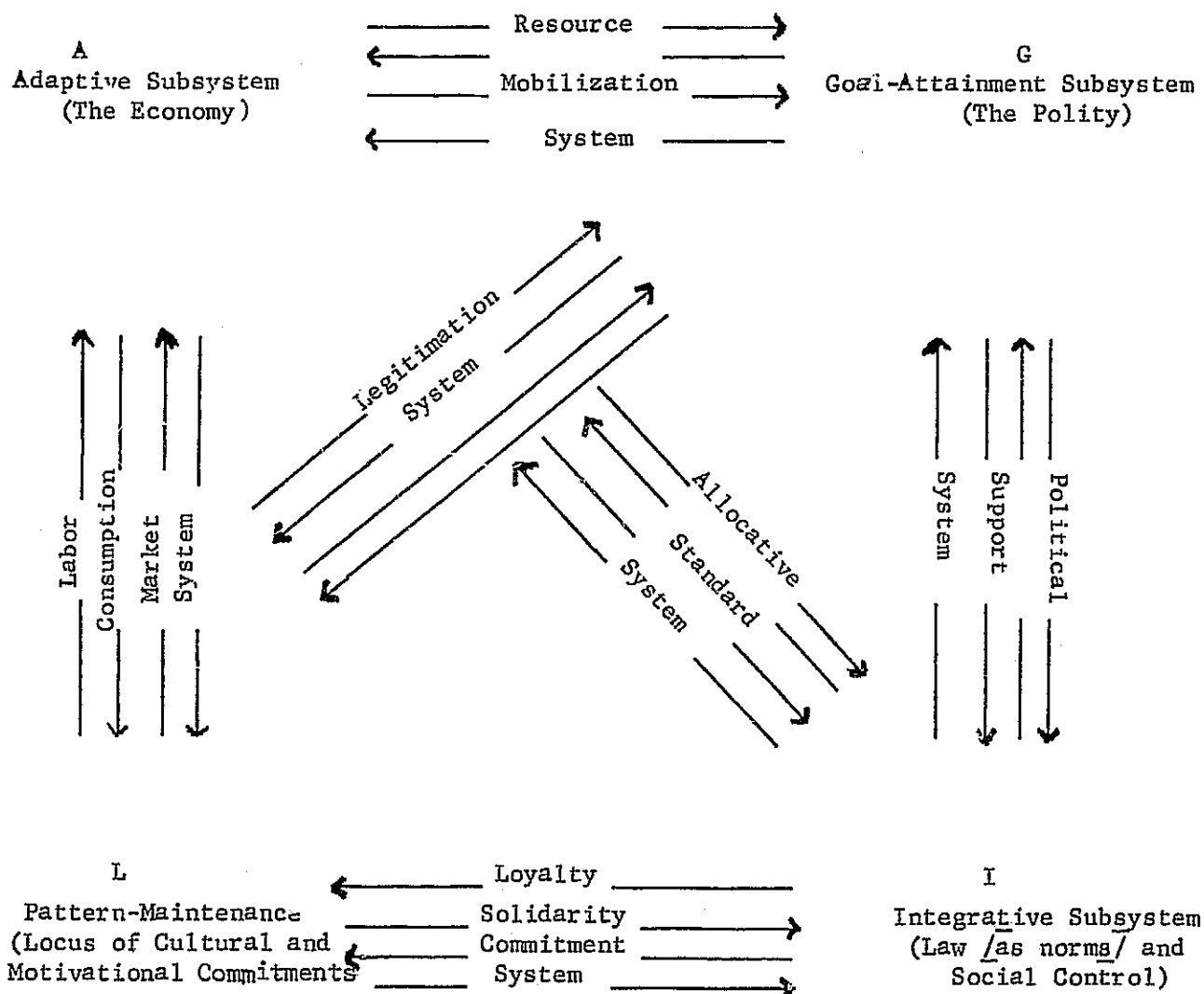
These subsystems are distinct according to Parsons because of the primacy of the function of structural units. In clarifying this he notes, for example, "there is an important structural difference between a private business firm, an administrative agency of government and a court of law". [178] However, each of these structural units are involved in a multiplicity of interchange relations with respect to most of its functional requirements from its situation and the conditions of its contributions to the other units. Parsons concludes that this differentiation is the basis for requiring double interchanges between all the structural units of a system. The "inputs/outputs" notions involved here demand the development of a generalized symbolic media to articulate and govern the interchange process. Parsons considers such media to include money, power and influence. Though he doesn't limit the media to these three forms.

In examining further the subsystems of the Parsonian model the following clarifications are helpful. The adaptive subsystem is roughly equatable with the economy. The goal-attainment subsystem refers to the "polity" and their programmed end states. The integrative subsystem is concerned with the law and social control while the pattern maintenance subsystem is the locus of cultural and motivational commitments.

Parsons creates a paradigm to illustrate these complex relationships. It will also be noted in this paradigm (Figure 34) that the functional interchanges between the subsystems are specified in terms of the major content of these exchanges.

Figure 34.

Format of the Societal Interchange System



In the present benefit-cost approach each of these subsystems, the processes of social action, and the institutions of each of the subsystems are included. In this sense, the social systems model is seen as providing orientation in a benefit-cost sense. The operationalization, which is addressed later, is dependent on the processes binding people into the subsystems.

Parsons addresses another important facet associated with benefit-cost from a systems point of view, that is, vested interests. He also presents a rather succinct analysis of the operation of the social system in a somewhat lengthy, but important, discussion of the social system paradigm. This discussion is presented in its entirety below.

For the benefit of readers with more technical interests in social system theory it has seemed advisable to present a very brief outline of the most directly relevant parts of the general paradigm here, with a brief elucidation of its relevance to the above discussion.

The structural reference points are essentially two, namely first that at a sufficiently high level of differentiation of a society economy, polity and integrative system become empirically distinct in terms of the primacy of function of structural units e.g. there is an important structural difference between a private business firm, an administrative agency of government and a court of law. Secondly, every such unit is involved in plural interchange relations with other units with respect to most of its functional requirements from its situation — i.e., for factor inputs — and the conditions of making its contributions to other units in the "division of labor" — i.e., disposal of "product outputs". This order of differentiation requires double interchanges between all the structural components belonging to each category-pair, e.g. firms and households, firms and political agencies (not necessarily governmental, it should be remembered) etc. The double interchange situation precludes mediation of processes in terms either of ascriptive expectations or barter arrangements, or a combination of the two. It necessitates the development of generalized symbolic media, of which we have treated money, power, and influence as cases.

At a sufficiently high level of generalized development the "governing" interchanges (in the sense of cybernetic hierarchy) take place between the media which are anchored in the various functional subsystems — as power is anchored in the polity. These media in turn serve as instrumentalities of gaining control of "lower-order" resources which are necessary for fulfillment of expectations. Thus the expenditure of money for "goods" is not, at the system or "aggregate" level (as analyzed by Keynes), acquisition of the possession of particular commodities, but consists in the generalized expectation of availability of goods on "satisfactory" market

terms. This is the primary output of the economy to consumers. Similarly, when we speak of control of productivity as a factor of effectiveness, it is not managerial control of particular plants which is meant, but control of a share of general productivity of the economy through market mechanisms, without specification of particulars.

The paradigm of interchange between general media of communication is presented in Figures 34 and 35. Figure 34 (reproduced earlier) simply designates the format in which this part of the paradigm is conceived. The assumptions of this format are three, none of which can be grounded or justified within the limits of the present exposition. These are (1) that the patterns of differentiation of social system can be analyzed in terms of four primary functional categories, each of which is the focus of a primary functional subsystem of the society. As noted in the body of the essay, economy and polity are conceived to be subsystems; (2) The primary interchange processes through which these subsystems are integrated with each other operate through generalized symbolic media of the type which I have assumed money and power to be, and (3) at the level of differentiation of interest here, each interchange system is a double interchange, implying both the "alienation" of resources and products from their system of origin and the transcending of the barter level of exchange. Under these assumptions all Figure 34 does is to portray a system of six double interchanges operating between each logically given pair among the four primary functional subsystems of a society. For convenience tentative names are given to each of these six double interchange systems.

Figure 35, then, places each of the six interchange systems on a horizontal axis, simply because they are easier to read that way. It adds to Figure 34 only by introducing names of categories, directions of flow and designations as to medium (money, power, etc.) for each of the four places in each of the six interchange systems, thus presenting twenty-four categories, each of the four basic media appearing in four "forms".

Among the six interchange sets, power as a medium is involved, by our analysis, in only three, namely the interchanges of the polity (G) with each of the other three. These are the system of "resource mobilization", vis-a-vis the economy, the support system which involves the input of political support and the output of decisions (vis-a-vis the integrative system) and the system of legitimation, as I have called it, vis-a-vis the value aspect of the pattern-maintenance system. The last of these three is a special case which does not involve power as a medium, but rather the structure of the code governing authority as defining the institutionalized uses of power, hence the legitimation of authority. Primary attention can thus be given to the other two.

The categories included in the A-G (economy-polity, or resource mobilization) interchange can be described as "forms" of power and of money (or wealth) respectively. They will be seen to be the categories which have been used in the appropriate parts of the discursive exposition of the body of the paper. The double interchange here, as in the classic economy — or labor consumption case, involves first one-factor-interchange, namely control of productivity as factor of effectiveness exchanged for opportunity for effectiveness (in the particular case of capital, as a factor of production). Productivity is a monetary factor because it is a pool of resources controlled through monetary funds — which of course in turn can be exchanged for the particular facilities needed, notably goods and services. Opportunity, however, is a form of power in the sense discussed.

The second part of the double interchange is one of "product" outputs. This takes place between commitment of services to organization — typically through employment — which I have interpreted to be a form of power, and the allocation of fluid resources to the purveyors of service as facilities essential to the performance of their obligations — typically the control of budgeted funds, though often generalization does not extend as high as this. Thus fluid resources in the ideal type case take the form of money funds.

The second primary interchange system, which for convenience I shall call the support system, is that between polity and integrative system (G-I), which later involves the association aspect of group structure and solidarity in relation to the system of norms (legal and informal) — as distinguished from values. The basic difference lies in the fact that power here is interchanged not with money but with influence, and that whereas vis-a-vis money it was the "controlling" medium, vis-a-vis influence it is controlled. This difference is symbolized by the placing of the power categories here in the outside positions whereas in the A-G case they were placed inside (as the monetary categories were in L-A).

The relevant factor interchange here is between policy decisions as a "factor of solidarity" and interest-demands as a factor of effectiveness, in the senses in which these concepts were used above. Essentially we may say that interest-demands "define the situation" for political decision-making — which of course is by no means to say that demands in their initial form are or should be simply "granted" without modification. Like other factors they are typically transformed in the course of the political process. Correspondingly policy decisions are a factor in solidarity in that they constitute commitments for collective action on which "interested parties" within limits can count.

FIGURE 35

The Categories of Societal Interchange

A	FACTORS	In to G	<u>Control of Productivity</u>	M2b	G
		In to A	<u>Opportunity for Effectiveness</u>	P1b	
	PRODUCTS	Out to G	<u>Commitment of Services to the Collectivity</u>	P1a	
		Out to A	<u>Allocation of Fluid Resources (financial)</u>	M2a	
L	FACTORS	In to A	<u>Labor Capacity</u>	C2b	A
		In to L	<u>Wage Income</u>	M1b	
	PRODUCTS	Out to A	<u>Commodity Demand</u>	M1a	
		Out to L	<u>Commitment to Production of Goods</u>	C2a	
G	FACTORS	In to I	<u>Policy Decisions</u>	P2a	I
		In to G	<u>Interest - Demands</u>	I1a	
	PRODUCTS	Out to I	<u>Leadership Responsibility</u>	I1b	
		Out to G	<u>Political Support</u>	P2b	
L	FACTORS	In to L	<u>Justifications for Allocation of Loyalties</u>	I2a	I
		In to I	<u>Commitment to Valued Association</u>	C1a	
	PRODUCTS	Out to L	<u>Commitments to Common Value</u>	C1b	
		Out to I	<u>Value-based Claims to Loyalties</u>	I2b	
A	FACTORS	In to I	<u>Assertion of Claims to Resources</u>	M3a	I
		In to A	<u>Standards for Allocation of Resources</u>	I3a	
	PRODUCTS	Out to I	<u>Grounds for Justification of Claims</u>	I3b	
		Out to A	<u>Ranking of Claims (Budgeting)</u>	M3b	

FIGURE 35 - Continued

FACTORS	In to L	<u>Operative Responsibility</u>	P3a	L
	In to G	<u>Legitimation of Authority</u>	C3a	
PRODUCTS	Out to L	<u>Moral Responsibility for Collective Interest</u>	C3b	L
	Out to G	<u>Legality of Powers of Office</u>	P3b	

M = Money

P = Power

I = Influence

C = Commitments

1, 2, 3 = Order of hierarchical control as between media.

a, b = Order of hierarchical control within interchange systems.

"In" means Input of category of resources to the subsystem indicated from the other member of the pair.

"Out" means Output of a category of "product" from the indicated source to the relevant destination.

Every double interchange consists of one input (factor) interchange and one output (product) interchange.

The interchange of "product" outputs then consists of leadership responsibility as output of the polity (a form of influence, note not of power), and political support as an output of the "associational" system — in the governmental case e.g. the electorate, which is a source of the political "income" of power. It will of course be noted that the units involved in any particular case of these two interchanges typically are not the same — thus party leaders may bid for support whereas administrative officials make certain policy decisions. This type of "split" (carried out to varying degrees) is characteristic of any highly differentiated system.

Figure 36 attempts to look at the generalized media from the point of view not only of their hierarchical ordering, but of the relation between the code and message components, and the position of the latter as sanctions controlling on the one hand factors essential to the various functional sub-systems, on the other hand product outputs from these sub-systems. The rows are arranged from top to bottom in terms of the familiar hierarchy of control — each row designating one of the four media. The columns, on the other hand, designate components into which each medium needs to be broken down if some of the basic conditions of its operation in mediating interaction are to be understood.

In the body of the paper I have discussed the reasons for which it seems necessary to distinguish two components in the code aspect of each medium, namely what have been called the relevant value principle on the one hand, the "coordinative standard" on the other. The most familiar example concerns the paradigmatic economic case. Here the famous concept of utility seems to be the relevant value principle whereas that of solvency is the coordinative standard. Utility is the basic "measure" of value in the economic sense, whereas the imperative to maintain solvency is a category of norm for the guidance of units in economic action. For the political case I have adopted the concept of effectiveness in Barnard's sense as the parallel to the economist's utility. Success, for the unit in question, notably the collective ease, seems to be the best available term for the corresponding coordinative standard. (Possibly, used with proper qualifications, the term sovereignty might be still more appropriate for this standard.)

At the other most important direct boundary of the polity, solidarity in Durkheim's sense seems to be the value-principle of integration which is parallel to utility and effectiveness, whereas the very important (to political theory) concept of consensus seems adequately to formulate the relevant integrative coordinative standard. Since they are not directly involved in the interchange systems of immediate concern here, I merely

call attention to the designation of the value-principle of the pattern-maintenance system as integrity and the corresponding coordinative standard as pattern-consistency.

The A and G columns of Figure 36 then designate contexts of operation of each of the four media as sanctions, but arranged not by interchange system as in Figure 35, but by control of factor inputs and product outputs respectively. Thus money though not itself a factor of production, "controls", i.e. buys, labor and capital as the primary factors, in the A-L and the A-G interchange systems respectively, whereas for "consuming" systems money buys outputs of the economy, namely goods (in A-L) and services (in A-G) respectively.

The involvement of power is conceived to be parallel. On the one hand, it "commands" the two primary mobile factors of effectiveness, namely control of productivity (in G-A) and interest-demands (in G-I) (as justified in terms of appeal to norms). On the other hand, the "consumers" or beneficiaries of the outputs from the process can use power to command these outputs in the form of fluid resources (e.g. through budget allocation in G-A) and of leadership responsibility for valued goals (in G-I).

It will be noted that in Figure 36 negative and positive sanction types alternate in the hierarchy of control. Power, as the medium depending on negative situational sanctions is "sandwiched" between money (below it) with its positive situational sanctions and influence (above it) with its positive intentional sanctions.

Returning to Figure 35, power is also involved in the legitimation system (L-G), but this time as code, as aspect of authority. This may be conceived as a mechanism for linking the principles and standards in the L and G rows. What is called the assumption of operative responsibility (P3a), which is treated as a "factor of integrity" is responsibility for success in the implementation of the value-principles, not only of collective effectiveness, but of integrity of the paramount societal value-pattern. It may be said that the legitimation of authority (C3a) "imposes" the responsibility to attempt such success. Legality of the powers of office on the other hand (P3c), as a category of output to the polity, is an application of the standard of pattern-consistency. At the various relevant levels action may and should be taken consistent with the value-commitments. In exchange for legal authorization to take such action, the responsible office-holder must accept moral responsibility for his use of power and his decisions of interpretation (C3b). [178]

FIGURE 36

The Media as Sanctions

Components of Media and Interchange Reciprocals		<u>CODES</u>		<u>MESSAGES</u> (Sanctions)		Types of Sanction and of Effect
Media in Hierarchy of Control		VALUE-PRINCIPLE	COORDINATION STANDARD	FACTORS CONTROLLED	PRODUCTS CONTROLLED	
222	L					
	COMMITMENTS	Integrity	Pattern-Consistency	Wages Justification of Loyalties	Source A I Consumers' Demand Claims to Loyalties	Destination A I Negative-Intentional (activation of commitments)
	I					
	INFLUENCE	Solidarity	Consensus	Commitments to Valued Association Policy Decisions	L G Commitment to Common Values Political Support	L G Positive-Intentional (Persuasion)
	G					
	POWER	Effectiveness	Success	Interest Demands Control of Productivity	I A Leadership Responsibility Control of Fluid Resources	I A Negative-Situational (Securing Compliance)
	A					
	MONEY	Utility	Solvency	Capital Labor	G L Commitment of Services Expectation of Goods	G L Positive-Situational (Inducement)

Both these social systems models share several common features. For example, both attempt to present what is essentially a general theory of organization through inclusion of several facets of social science. As with most such endeavors both system approaches fall short. However, they do provide us with systems notions and a basis for systems analysis. They are both essentially abstractions which treat phenomena and the concepts used to organize the phenomena as if there existed organization, an integration of the parts, interaction, and interdependency. In addition, while both Pareto and Parsons speak of boundaries or parameters, they consider their systems views of society to be "open" in the sense it is not isolated from its environment. It should be noted, however, that the major concentration in these works is on elaboration of the sub-elements or subsystems and the processes articulating these systems.

Both Pareto and Parsons also consider the social system to tend toward internal stability. That is, they consider equilibrium as operating but not in the sense that a steady state is maintained around a fixed point. Rather, they allow for a morphogenic condition allowing for change in the system's form, structure, or state, so that the system comes to exist at a new and more complex level of equilibrium.

Another problem considered by most systems theorists is entropy and negentropy. Entropy is seen as a measure of disorder and negentropy as a measure of order. All closed systems tend to increase their entropy. However, the social system is considered as an open system which means it is capable of maintaining a relatively low level of entropy by interacting with its environment. However, this interaction usually results in a more complex structure. Norbert Wiener has drawn a comparison between entropy and communications which is relevant to the social system. In this scheme entropy brings disorder and communication contributes to order or negentropy. The negentropic function of communication in the social system is linked to the informational feedback function of communication which is seen as being cybernetically controlled. Both Pareto and Parsons introduce this principle into their discussion of the social system.

6. SOCIAL SYSTEMS CHANGE

In Pareto's theory the "sentiment system" controls the feedback and the form of the social system automatically seeks to achieve its end state. Parsons discusses both the feedback and cybernetic notions in relation to societal interchange. In an earlier study [177] this societal interchange process was used in attempting to discuss juvenile gang activity in the Robert Taylor Homes area of Chicago. The purpose was to show how gang activity is related to the interaction or societal interchange among the four subsystems postulated in Parsons' paradigm. In the following quotation the symbols are as follows: G, represents the goal-attainment subsystem; I, the integrative subsystem; A, the adaptive subsystem; and L, the pattern maintenance subsystem.

Our first area of concentration will be the Goal-attainment and the Integrative subsystems. We have as a result of gang activity certain policy decisions being given, this is a power output from G and an input to I. This output from G has been brought about by an input from I in the form of interest and demands, that is, those involved made certain demands for a policy statement concerning juvenile gang activity.

This first exchange is representative of the factors involved. This exchange will in turn be followed by a second exchange which will represent the product of the previous exchange.

This previous exchange was met by a certain leadership responsibility, that is the precinct captains and law enforcement agencies gave responsible leadership, which is represented as an output from G to I. This in turn is followed by a power move, that is, political support, which is represented as an input to G from I.

Now let us turn our attention to the Pattern-maintenance subsystem and its societal interchange with the Integrative subsystem. Symbols used in showing these inputs and outputs refer to Figure 35. I presents to L justification for the allocation of loyalties, in our case justification for allocation of loyalties to follow these proposed norms and sanctions against the juvenile gangs, which is followed by a commitment to a valued association, that is L commits itself to an association with I or the input is to I. Again, this first exchange represents the factors involved and now we will view the products of that exchange. In this instance the subsystem I commits itself to the common value, which in our case will be maintaining the existing patterns by enforcing the norms. This in turn will be followed by an output from L to I. The product of this exchange will be value-based claims to loyalties. [177]

While this is only a partial view of the complete societal interchange process, it is felt to be sufficient to make the point. The basic processes of interchange are proposed by Parsons, in this case they are applied as analytical tools in the concrete situation of the Robert Taylor Homes. However, the terminology, such as, "input", "output", "receptor", etc., which Parsons uses, is noteworthy since they represent the basis for introducing the concept of cybernetics. An attempt is thus made to demonstrate that the goals of a subsystem are affected by the interaction process through a feedback network and, further, that the overall "form" or the goals of the entire system are clearly dependent and further determined by this informational exchange.

This discussion deals with intra-systems change. Parsons also deals with inter-systems exchanges which are felt to affect the overall form of the system. In this example the boundary maintenance function becomes an important one for understanding social systems change.

It is also the case that system boundaries are permeable: they system and its environment interpenetrate each other. A system is an ordered aggregate embedded in, and in interaction with, a fluctuating environment.

In attempting to relate the problems that flow from this interpenetration, and in order to demonstrate the connectedness of system and environment, Parsons uses as an example the adaptive problems of a system. Also contained in his example are a couple more ideas crucial to the present modification.

Consider, for an example, the "adaptive" problems implied by interpenetration and differential randomness (two terms he is currently considering). Not only must system boundaries, by some mechanism(s), be maintained in relative integrity, but by some mechanisms(s) the system must both draw "sustenance" from the environment and "defend itself" against extreme environmental fluctuation. At the boundary of the system - permeable, open to environmental impingement and intrusion -- there must be filtration mechanisms, accepting and rejecting possible environmental inputs, and regulatory mechanisms, minimizing environmental fluctuation either by direct action into the environment toward control of its relevant aspects or, at least, by neutralizing those effects of such fluctuation as cannot effectively be controlled. [179]

The real importance of this statement lies in the fact that it paves the way for the introduction of the concept of cybernetics. For, in fact, Parsons has just laid the foundations for the "feedback network" so vital to a cybernetic model. However, there is one more concept that Parsons must clarify and that is function. The reason for such a statement is that, function is the final necessary factor Parsons uses before he introduces the cybernetic concept into his own model.

A function is an energetic output of an action system into another system, controlled informationally by the adaptive mechanisms of that receptor system. As output, what is delivered flows "outward-bound" across the goal-attainment boundary of the delivery system; as input, what is received flows "inward-bound" across the adaptive boundary of the receiving system. The locus of function is the goal-attainment sector of the relevant delivering system. [179]

It is now clear, the stage has been set, and all that remains is to explain how the interaction process works. Parsons presents a discussion of that aspect in a consideration of the energetic hierarchy of conditions and the informational hierarchy of controls.

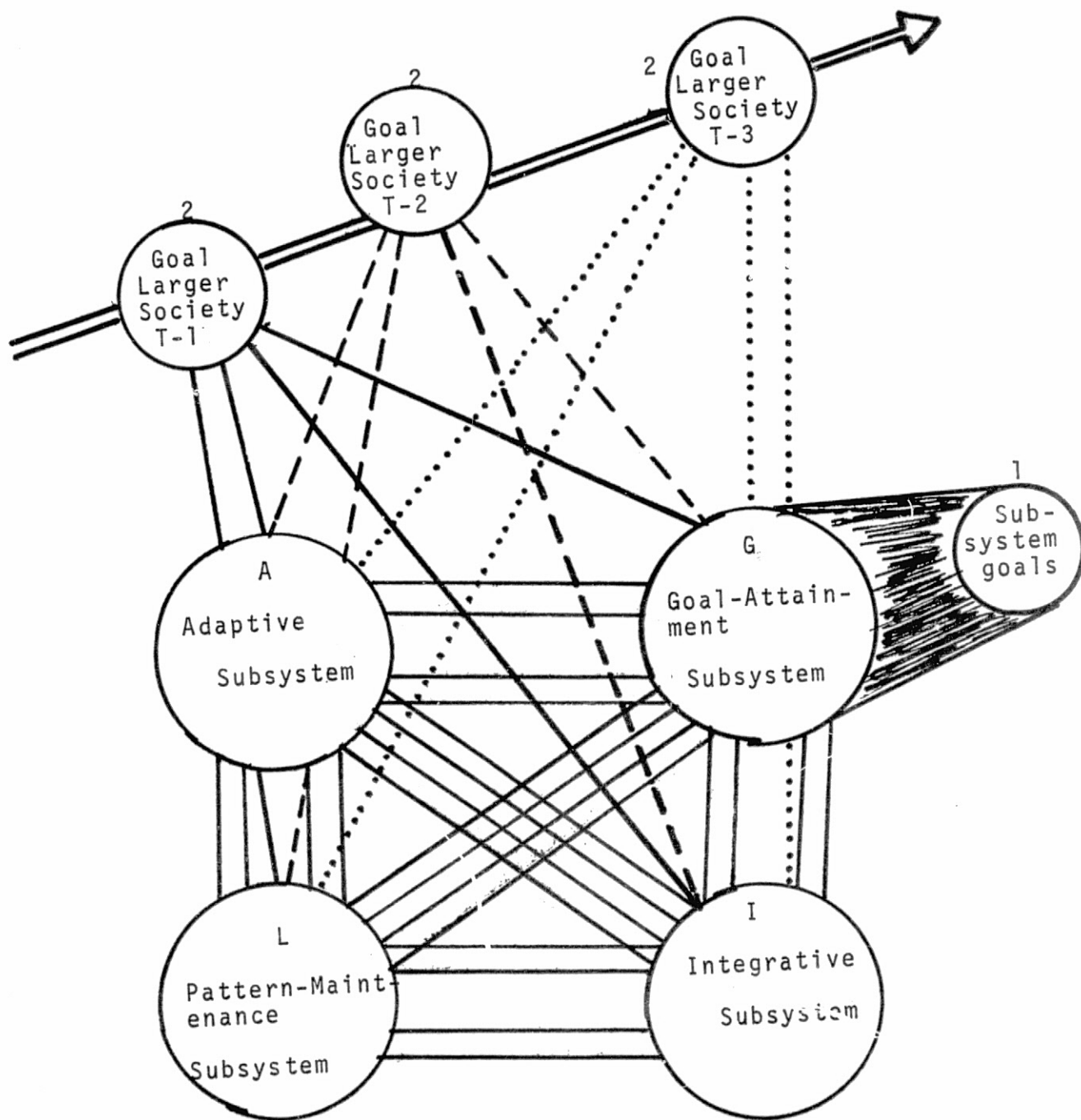


Figure 37.

We have, however, implied them (the two aforementioned concepts) by pointing out that the concept "system" leads us to the further concept of control mechanisms existing at the adaptive boundary and adjusting possible environmental inputs. These control mechanisms are informational in the cybernetic sense, just as inputs are energetic in the cybernetic sense. It is information which guides, constrains, adjusts; it is energy which activates. [179]

One of the major criticisms of Parsons systems theory is that it does not allow for social change since it is a "closed systems" model. In summary, however, these criticisms are shown to be somewhat unfounded, for, in addition to his discussion of the four subsystem and the interaction process occurring between them, he introduces the concept of feedback and cybernetics and discusses these in relation to environmental inputs. This feedback operates within each of the subsystems and it is only when a "goal" or "approved idea" or "projected pattern of action", "etc." is decided upon that an informational exchange will occur. The subsystem will function by attempting to accomplish its assigned goal and it is our contention that, it is through the informational exchange occurring between the subsystems, which is cybernetically controlled, that the goals of the given subsystem are altered. That is to say, change, which can be referred to as intra-systems change, occurs in a process of interaction with the other components of the system. This process of intra-systems change is illustrated in Figure 37.

In this figure, A, G, L, and I refer to the functional subsystems of a society. The four sets of solid lines represent the informational exchange between the subsystems. Numeral one (1) represents the specific goals of a given subsystem. These goals are formulated or determined in the process of interaction by all those variables which are pertinent to the functions of the subsystem. While there is only one drawn in the illustration, each subsystem in a social system (society) has these goals. Numeral two (2) indicates the goals of the social system. These goals are those agreed upon ends toward which the system is moving. These are the result of the process of informational exchange with the other functional subsystems of the society. A time sequence is also shown to portray the fact that the goals of the society are constantly changing through the process of interaction and that once the goals are changed the social system automatically (through or in a cybernetic fashion) moves toward that new determination. The large arrow through the social systems goals is meant to show that there is a direction which the social system takes, that is, there is not random movement, but rather, a determined direction. This direction is determined by the societal goals which, in turn, are constantly shifting through a process of interaction. What is important is the notion that societies (social systems) operate on a cybernetic principle and, therefore, once the goal is determined the system will automatically move towards it. Of course the complexity and ever shifting nature of these goals makes actual and complete determination impossible. However, the general directions of a society can be determined.

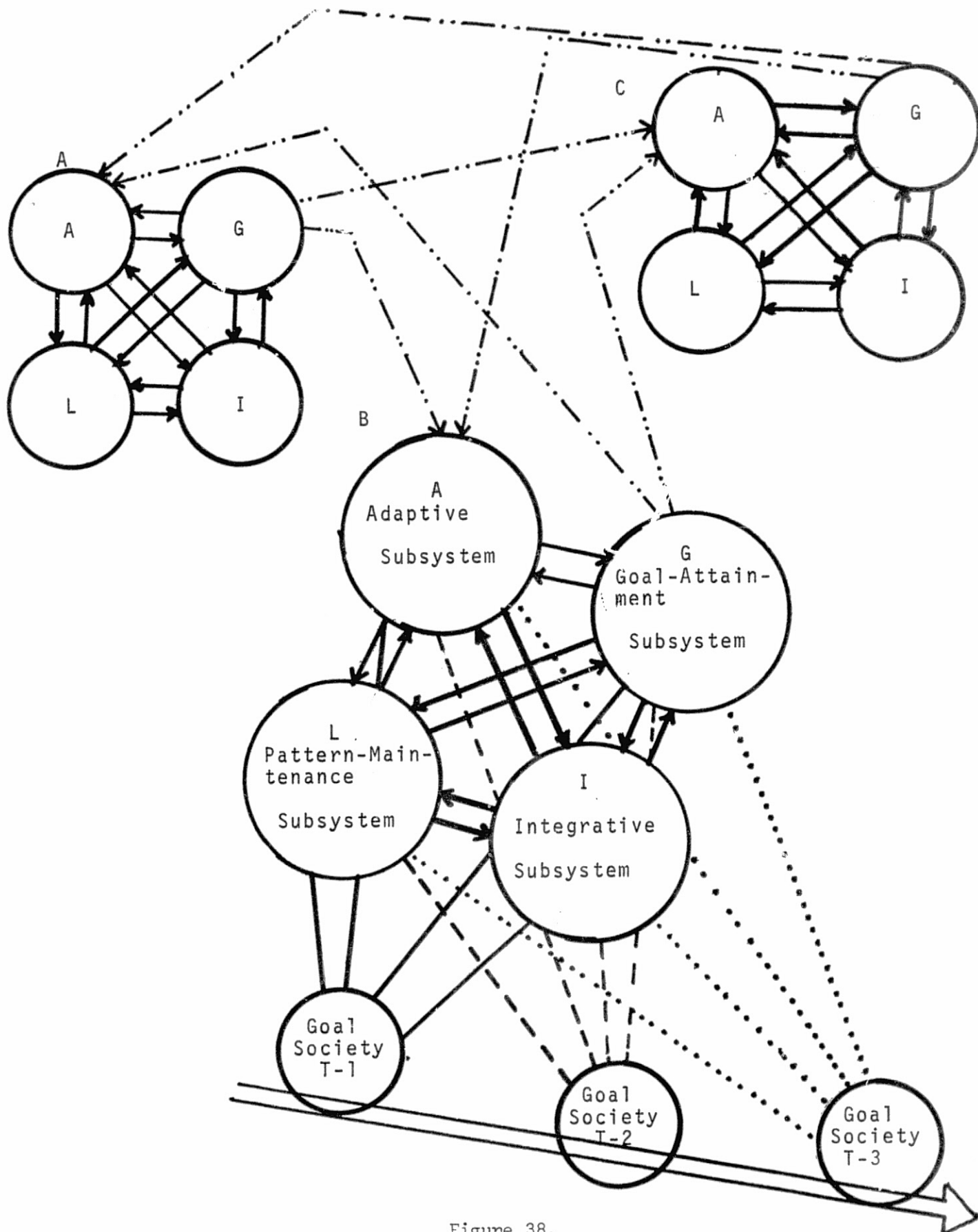


Figure 38.

Inter-systems change may also be illustrated. Figure 38, illustrates this process by showing the social systems involved in a process of informational exchange. These systems, labeled A, B, C, are exchanging information with the outputs going from the Goal-Attainment subsystems of the respective social systems into the Adaptational subsystems of the other social systems. These exchanges are denoted through the broken and dotted lines. It is held that these informational exchanges have an effect on the determination of the goals of the particular social systems involved.

Thus, the form and/or direction of a given social system is not only the result of intra-systems decisions, but incorporates the inputs and outputs to different social systems with which it interacts. This represents to some degree a change in the theorizing of Pareto discussed in this paper in the sense that he proposes that all changes outside the system including pressures for change will be resisted by the society and that the society will immediately return to those intra-systems goals.

Consideration of change is very important to any consideration of benefits and costs in the sense that innovations and new technologies impact differentially at a variety of points. For example, such innovations may have implications for the social system generally in terms of its direction, form, or perhaps its very existence as an on-going concern. It might impact primarily at the subsystem or institutional level of organization in such a manner as to alter the goals and operations of the level. This type impact has implications for the whole system. Additionally, such innovations might impact on the processes, beliefs, or sentiments of groups of persons within the social system. In the Parsonian paradigm such impacts are viewed as subsystem and function problems. Pareto, on the other hand, presents a different view by focusing on the processes intrinsic to man himself.

7. PARETO'S THEORY OF SYSTEMS CHANGE

Pareto sets as the specific goal of his sociological theory a determination of the form society assumes. He notes:

The examination of residues and derivations that we have just completed has acquainted us with the manifestations of certain forces which influence human society and consequently with those forces themselves. So step by step we are gradually approaching our own goal, which has been to discover the form that society assumes in virtue of the forces acting upon it. [180]

The forces acting upon a society and those which consequently determine the form that society will achieve are grouped by Pareto into three groups. This process of action by the forces is more than just a one way process, it involves an interaction of the elements with the society itself.

The form of a society is determined by all the elements acting upon it and it, in turn, reacts upon them. We may, therefore, say that a reciprocal determination arises. Among such elements the following groups may be distinguished: (1) soil, climate, flora, fauna, geological, mineralogical, and other like conditions; (2) elements external to a given society at a given time, such as the influences of other societies upon it -- external, therefore, in space; and the effects of the previous situation within it -- external, therefore, in time; then (3) internal elements, chief among which, race, residues (or better, the sentiments manifested by them), proclivities, interests, aptitudes for thought and observation, state of knowledge, and so on. Derivations also are counted among these latter.

Pareto's view is quite inclusive in terms of the potential sources of change. He also points to the notion that change occurs in the process of interaction and that the new form the society achieves is the result of the relationship between the three major types of forces acting upon it. These processes and the resultant form of a society are illustrated by Pareto in a letter he wrote to a friend and fellow economist.

Think ... of so many little bits of lead attached together by elastic threads which interlace in a thousand ways. You cannot move one of the pieces of lead without altering the form of the whole system.³⁴ (Footnote 34 refers to the letter to his friend -- *Lettere a Maffio Pantaleoni*, G. de Rosa (ed.), 3 vols., Roma, 1960). [181]

Further on in his writings he states:

But however many, however few, the elements that we choose to consider, we assume at any rate they constitute a system, which we may call the "social system" [175]

Perhaps one of the most important or key terms in understanding Pareto's ideas on social change is the notion of "equilibrium". His idea of equilibrium is intimately tied to with his idea on the form of a society. If one were to grasp the form of this society or system, it would be necessary to know what all the elements involved in the system were, that is, all the aspects of the three earlier mentioned categories affecting the determination of the system. He says that the system changes both in form and in character in the course of time depending on the particular forces interacting with it. He goes on to say:

If we intend to reason at all strictly, our first obligation is to fix upon the state in which we are choosing to consider the social system, which is constantly changing in form. The real state, be it static or dynamic, of the system is determined by its condition. Let us imagine that some

modification in its form is induced artificially. At once a reaction will take place, tending to restore the changing form to its original state as modified by normal change. If that were not the case, the form, with its normal changes, would not be determined but would be a mere matter of chance. [175]

The term that must be grasped in this passage is "determined". It is essential in the sense that the form of society is determined by the forces acting upon it. In other words, if the form of society is determined by the forces acting upon it is logical to assume it will tend toward attaining that form. Once the form is attained as a result of these conditions, the society is in a state of equilibrium. It seems almost an unfortunate choice of words on Pareto's part to use the word equilibrium because of the implication that a system in equilibrium is static. However, that isn't what Pareto has in mind as is evidenced in the following discussion.

Pareto conceived of change as constantly occurring, that is, in so far as the forces both internal and external to the system change so does the system. This is the same as saying, if at time X there are 2,000 variables which determine the form of the system, the system will tend toward and attain that determination specified by those 2,000 variables. Now if at time two or X_2 there are 2,500 variables with 200 of the original 2,000 also changed, the system will tend toward this new determination; that is, the attainment of equilibrium. This concept is brought out clearly in both graph form and explanation by Pareto as follows:

To see the situation more clearly, we might look at a few examples. Pure economics afford a very simple one. Let us take a person who in a given unit of time - everyday, we will say - barter bread for wine. He begins with no wine, and stops bartering when he has a certain quantity of wine. In Figure 39, the axis of time is Ot , and $ab, bc, cd, de \dots$ are spaces representing equal unity of time. The axis of the quantities of wine is Oq . At the beginning of the first unit of time, the individual has no wine -- his position is at a ; at the end he has the quantity bX , of wine -- his position is at X_1 . Exactly the same transaction is repeated everyday, and at the end of everyday, or of every unit of time, the individual's position is at X_1, X_2, X_3, \dots . All those points fall within a line MP , parallel to Ot , and the distance between the two lines is equal to the quantity of wine the individual acquires through exchange each day. The line MP is called the line of equilibrium and, in general, is the line determined by the equations of pure economics. It does not have to be a line parallel to the axis Ot , for there is no reason why exactly the same transaction should be repeated everyday. It may, for example, be the line MP in Figure 40: $ab, bc, cd \dots$ are still

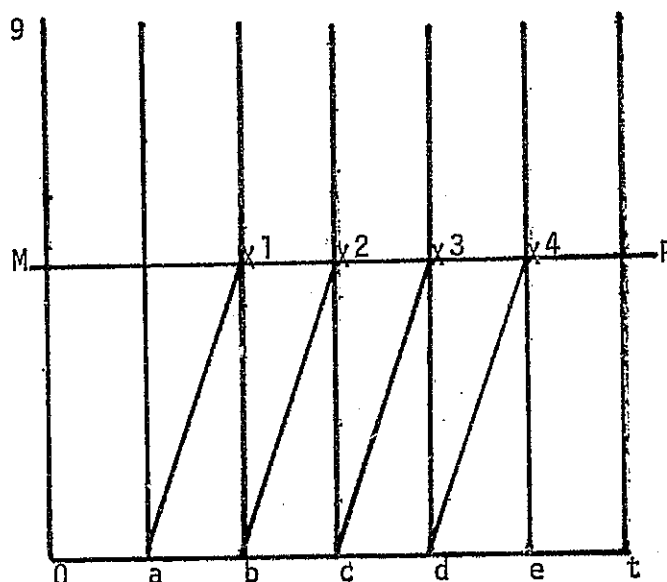


Figure 39

equal units of time, but at the beginnings of the various periods the individual's position is at a , s , r , d , u ... and at the ends at X_1 , X_2 , X_3 , X_4 , X_5 The line MX_1 , X_2 , X_3 , X_4 , X_5 ... is still called the line of equilibrium. When it is said that pure economics gives the theory of the economic equilibrium, it means that pure economics shows how the final positions, X_1 , X_2 , X_3 ... are reached from the points a , s , r , d , u ... and nothing more. Now let us consider the more general case. In Figure 40, ab , bc , cd ... are no longer equal to one another, but represent different periods of time, which we choose in order to examine a phenomenon at the end of each of them, the length of the period being determined by the time required for an element to complete the particular action that we have chosen to consider. The points a , s , r , d , u ... represent the state of the individual at the beginning of the action; X_1 , X_2 , X_3 ... the state of the individual when it is completed. The line MX_1 , X_2 ... P is the line of the state X .

... if we start in the first place with the definition just given of the state X_1 , we see that the action of each element having been completed, society cannot of itself assume any form other than the form X_1 , and that if it were made artificially to vary from that form, it should tend to resume it; for otherwise, its form would not be

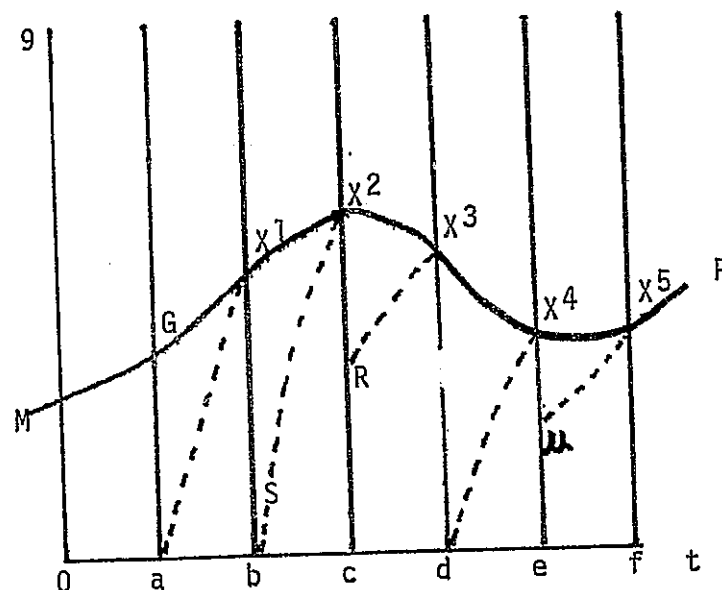


Figure 40

entirely determined, as was assumed, by the elements considered. In other words, if society has reached a point, X_1 (Figure 41) following such a path, aX_1 , that at X_1 the action of the elements which we choose to consider is complete; and if society is artificially made to vary from X_1 , the variation can be brought about only: (1) by forcing society to points such as $l, n \dots$ which are located outside the line aX_1 ; or (2) by forcing it to a point m on the line aX_1 . In the first case, society should tend to return to X_1 ; otherwise its state would not be completely determined, as was assumed, by the elements considered. In the second case, the hypothesis would be in contradiction with our assumption that the action of the elements is complete; for it is complete only at X_1 , and is incomplete at m ; at the latter point the elements considered are still in action and they carry society from m to X_1 . [175]

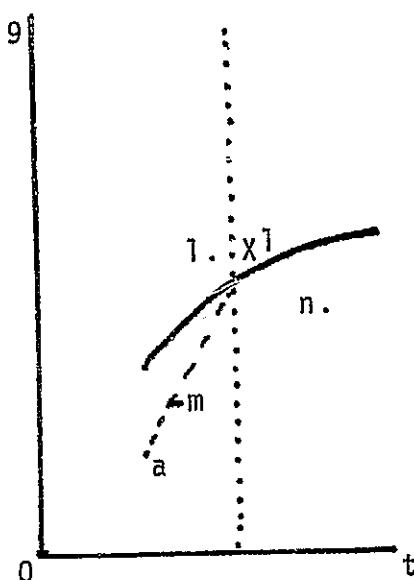


Figure 41

This discussion of change implies a good or an end state resulting from the interaction of the forces. Further, since changes in the three major groups of forces is part of the reality of the system, the process of change is a constant one. Yet, the system always tends toward a kind of dynamic relationship between the parts. Pareto calls this process dynamic equilibrium. Of all the factors implied in his discussion, perhaps none is more important than the point he makes regarding the complexity of the process.

Additionally, he notes that for the system to change in reality, the programming for that change, in terms of its permanence, must be incorporated as part of the "sentiment" system of the people of the system. If this does not happen, the system will automatically attempt to re-equilibrate itself in terms of the real sentiment system, as soon as the outside forces moving it away from those sentiments are removed.

In terms of a benefit-cost analysis it appears to us that, if the real benefits and costs are to be measured, we must provide a technique for getting at the real sentiment system which underlies and governs behavior. That is, the internal elements in Pareto's theory. Additionally, we must be able to determine the various segments of social reality which are likely to be affected. In the Parsonian scheme this means detecting the subsystems, institutions, and organizations likely to be impacted or benefited. In Pareto's scheme this involves the ecological elements and the internal elements as well. Both schemes note the importance of inter-systems relationships and, undoubtedly, benefit-cost analyses must include such interactions.

Ultimately this assessment, however, must deal with the manner in which man organizes, interprets, and acts within the system. Both these systems views, therefore, provide us with valuable insights. However, neither provide a firm basis for predicting benefits and costs since they address the macro-social level and do not provide us with insights into how man is integrated into that macro-social reality.

8. INTEGRATING PEOPLE INTO THE LEVELS OF ORGANIZATION

The potential complexity for predicting behavior begins to emerge when one views the many levels involved. However, to this point we have merely discussed the complexity of each level of organization from the individual through the social system. We now return to the level of the individual in order to show the processes through which the individual interprets and relates to this complexity.

In earlier schemes, man's behavior was felt to be predictable in terms of a given set of environmental factors. In fact, Pareto's conception of the social system is greatly concerned with such phenomena as physical climate, soils, land forms, flora, fauna, etc. However, such environmental determinism has given way to a new view, called environmental possibilism. This view, considering environmental factors as necessary rather than sufficient conditions, is conceptualized as including a set of opportunities fashioned by man. This paradigm is also largely rejected in that it casts man as essentially determined. The result of rejecting these deterministic paradigms is the creation of a third which allows for the explanation of human choices and decisions in the context of the relationships in which they occur. This paradigm is called the behavioral environmental approach. The major assumption is that man responds only to the environment as it is perceived by him. Therefore, his decisions and behavior with respect to any and all his activities have meaning only within his perceived environment. Since this environment can only be interpreted relative to a man's psychological processes, such processes must be included in explanations and assumptions about his behavior.

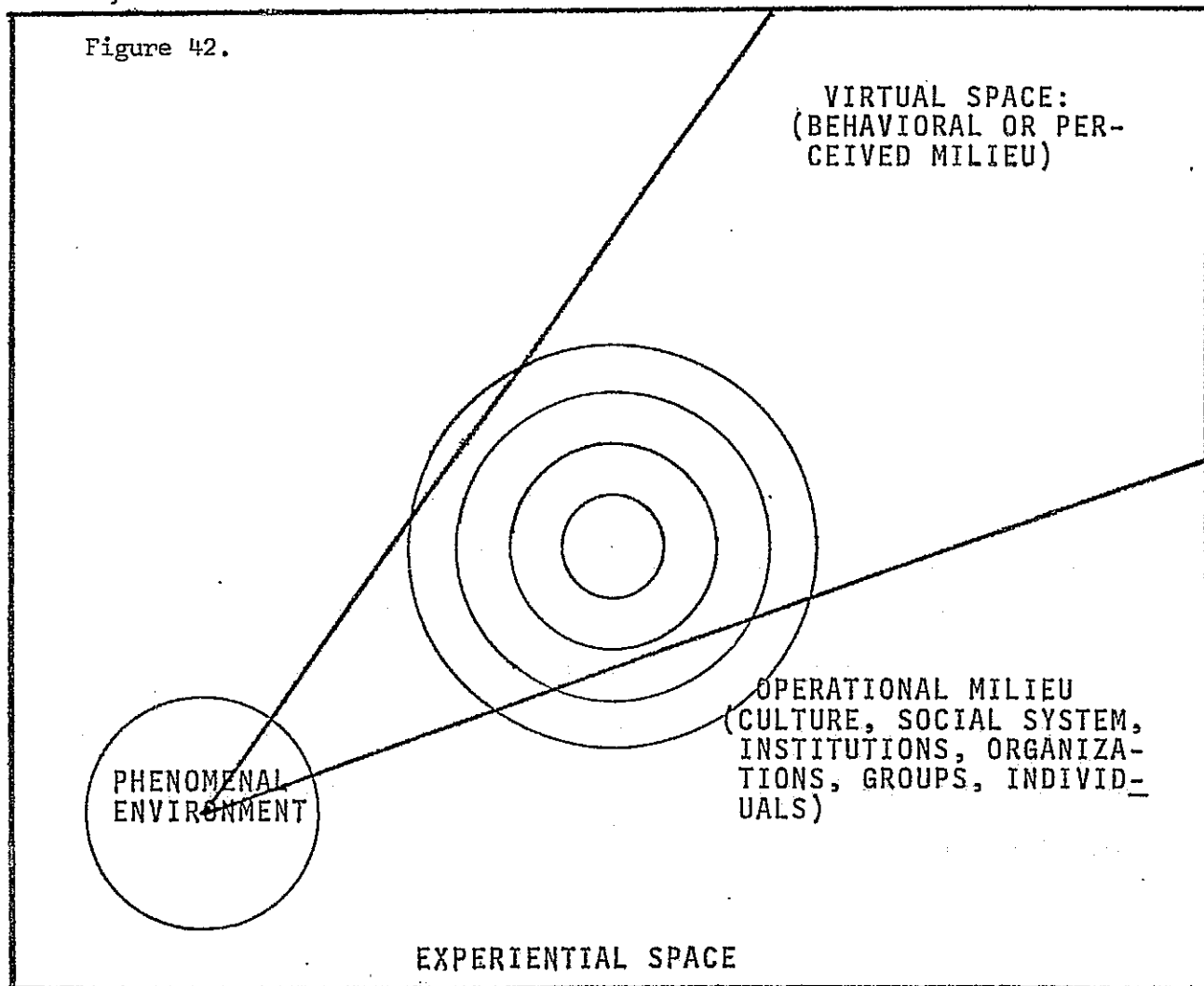
Human geographers have noted that in order to accomplish this degree of understanding of human behavior the phenomenal environment, the operational milieu, and the behavioral milieu must be considered. The phenomenal environment includes such things as physical resources, the biological setting, and other fixed entities. The operational milieu exists between the phenomenal environment and the actor. This milieu consists of the organizational elements of man's life including such things as values, institutions, organizations, norms, and so forth. It includes all the elements, for example, that govern production, consumption, and exchange functions. Finally, there is the social-psychological aspect of man, the behavioral environment, which takes account of the difference between the significance of environmental objects as perceived and those same objects as they exist in reality.

In order to completely understand these three milieux, the human geographers have included two more distinctions. The first is experiential space which is that "space known by sight and touch, by free motion and restraint, far and near sounds..." [182] In this sense it is that which is physically present to be experienced. In relation to our systems view of man, it is that which confronts the detector.

The second additional concept is virtual space which is the created domain of human relations and activities..." [182] Thus, it includes a particular way of perceiving experiential space and, as such, is a function of both the behavioral and operational milieux. In our systems view of man this function occurs in the selector.

The following figure is an adapted version of one presented by Michael Hurst [182]. In the adaptation we have substituted both the elements of social action theory and the levels of organization as the elements of the operational milieu. In Hurst's original figure the operational milieu is comprised of institutions, value systems, and political systems. In our adaptation we wish to show that all the levels of organization in which a person functions is part and parcel of the operational milieu. Additionally, we include the common elements for integrating people into these organizational levels, viz., values, norms, mobilization of motivation, and resource utilization.

Figure 42.



Each of the component environments may be considered as forming a complex integrated whole that represents social reality. Perhaps, it is useful to analyze these component environments in greater detail since the Total Assessment Profile is constructed partially around these models.

9. THE PHENOMENAL ENVIRONMENT

As noted above, this environment considers the natural environment. In this sense it is a physical realm. However, it also includes man and, therefore, it must also include everything that has been created or altered by man. These alterations may be viewed as both constructive and destructive to the physical environment. The ecosystem is considered as part of the phenomenal environment. This system is seen as an open system but tending toward a state of dynamic equilibrium. Alteration of a facet of the system ultimately has implications for the entire system. To complete this picture man and the changes he introduces must also be viewed. If, for example, one were to have studied the ecosystem 200 years ago and compare those findings with the present day situation, a greatly altered picture would emerge. Man's modifications of the ecosystem must have affected all the other elements of the system.

10. THE BEHAVIORAL ENVIRONMENT

Regardless of the objective or phenomenal environment in which man operates, it may not control either behavior or beliefs. That is, man may be for the most part, out of touch with the phenomenal world. That the phenomenal world exists, cannot be denied. But how it is perceived as existing is quite another matter. The interpretation of the objective world goes through a series of selective filters which represent the operational milieu. We have discussed this environment, as noted earlier, in terms of the "selector" facet of man. This means that the behavioral environment is an internalized environment consisting of images and ideas. However, a great deal of man's behavior is governed by responses to the images and ideas he has concerning the phenomenal and social world. Variation in these images, therefore, accounts for variation in human behavior at both the individual and group levels.

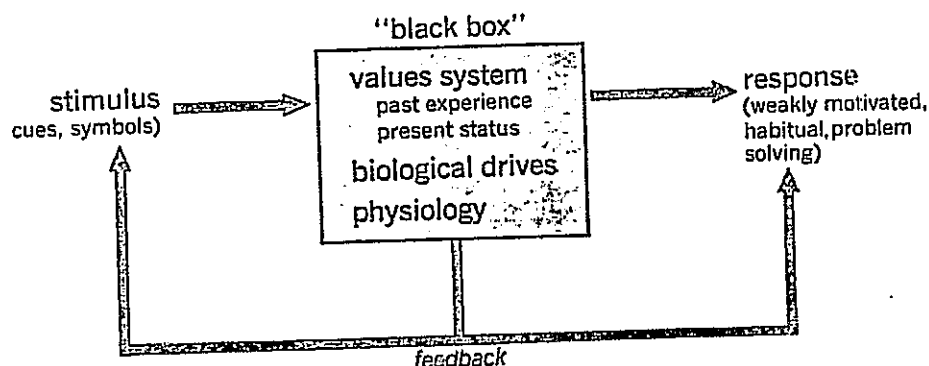
In our earlier discussions of the selector function, we noted that there is a kind of selection process going on which we now call selective perception. The basis for this selection is found in both the propensity of man to categorize and the attitudes, ideas, values, and belief system of the groups to which the person belongs. The group experience involves a sharing of common experiences, values, symbols, and so forth. He also confirms his reality in the process of interacting with members of his group. Hence, the perceptions derived are not accurate representations of the objective world but are rather representations as colored by attitudes, past experience, concepts, symbols, beliefs, values, and needs of the individual. It is in and through this

behavioral environment that the meaning and meaningfulness of the social world are derived.

Several psychological explanations have been offered to account for the processes involved in creating the behavioral environment. For example, the behaviorist would propose that there is a link between a stimulus and response which can be and is reinforced through repeated action. Man becomes a highly predictable being in such a scheme. The Gestalt theorists present a more rational view of man proposing that he learns to organize his world into a meaningful totality. In this view man learns what the parts of the totality are and can respond to them. However, the perception and the action of the perception of the response to the part, are organized in an attempt to achieve an ideal state of order.

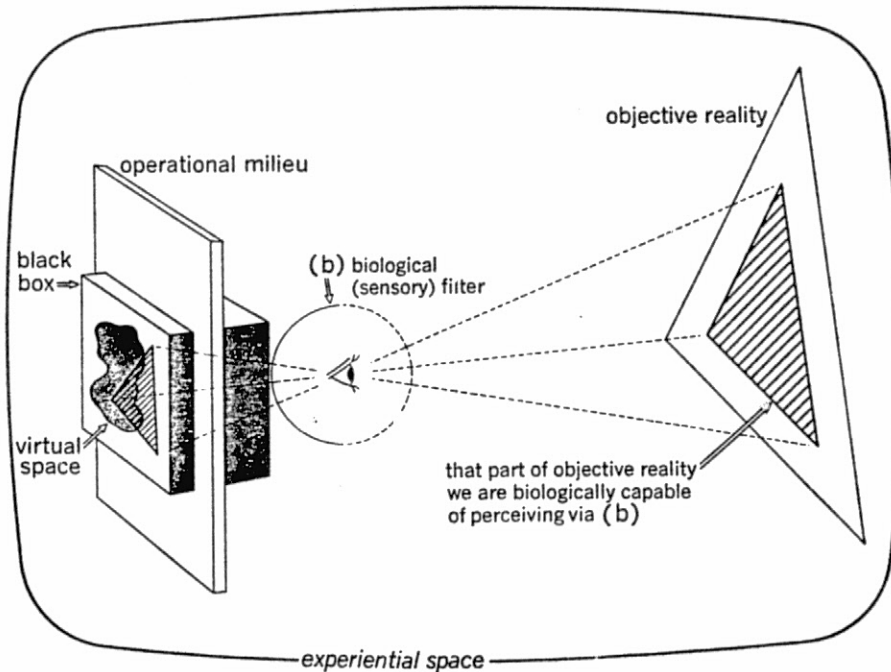
The ideas of both the behaviorists and the Gestalt psychologists are merged in a single theory by Osgood in a communication model. In this scheme a human is viewed as a communication unit capable of both sending (encoding) and receiving (decoding) a message. All this process takes place in the "black box" which really is meant to stand for the place where both the encoding and decoding process goes on. The result is an information processing system which involves external stimuli and group processes, as well as, the internal individual processes of learning, thinking, deciding and motor responses. The following figure taken from Hurst illustrates this process.

Figure 43



Hurst [182] borrows from all these psychological theories to create a new view of the behavioral environment. Figure 44 reproduced below is a representation of this reconceptualization.

Figure 44.

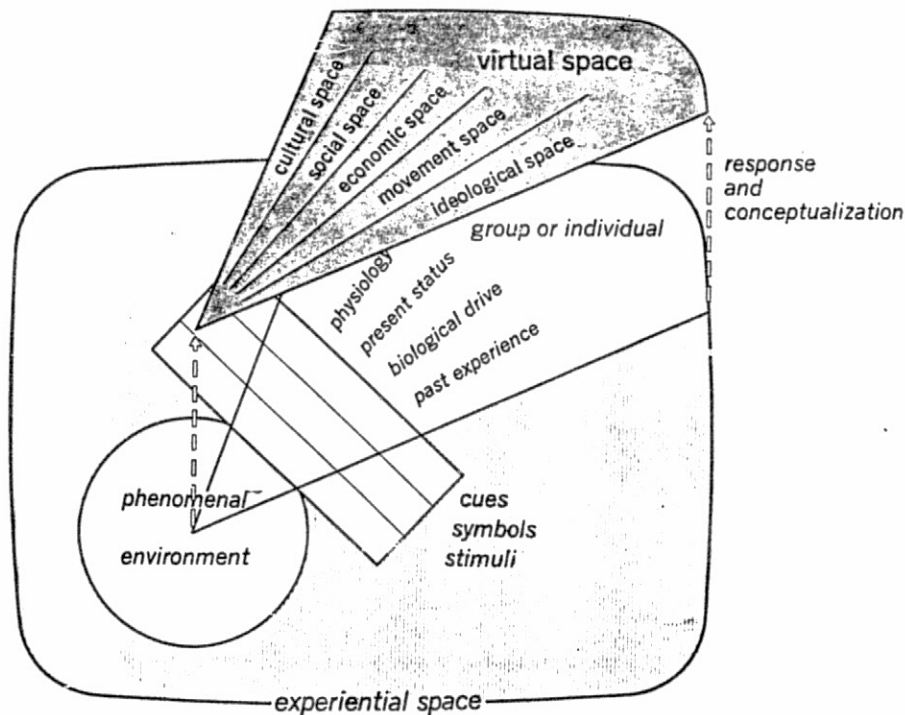


In Hurst's view experiential space is subject, first, to the constraints of the human time span and brain capacity. Secondly, it is subject to the biological limitations of the human sensory apparatus (b) Hurst goes on to say:

"Information is transmitted to the black box, which is where the operational milieu is partly internalized. Thus, objective reality is transformed within the black box into the subjective reality of virtual space, composed now of select elements and symbols of reality mixed with elements and symbols of illusion. It is virtual space that supplies the container or frame of reference for behavior, including economic behavior" [182].

In this eclectic view, Hurst has included the elements experiential space, the phenomenal environment, and the operational milieu to show how they overlap in virtual space in the "black box". He notes that it is possible to look within the black box and break virtual space down into a series of cognitive structures. He depicts these structures as cognitive symbolic spaces (Figure 45 on the following page, Hurst, [182]).

Figure 45. An Environmental System: Symbolization and Space.



Hurst notes that this idea of symbolic space is important and deserving of expansion since the creation and use of symbols is peculiar to man. The higher cognitive processes are dependent on them and they also serve the function of removing the organism from an environment of sounds, shapes, and smells to an environment of meaning.

"An act of symbolization can mediate between a stimulus and a response. Through many such acts, entire human groups can orient themselves to the phenomenal environment. Human society itself has been said to consist in shared symbolism." [182]

Hurst subsequently summarizes five kinds of space which are included in his model. These five are summarized as follows:

Cultural space is a set of landscape objects that are part of a group's cultural values, as expressed by designating such objects as "historic landmarks", "national monuments", and the like" [182].

This notion of culture, it should be noted, is somewhat abbreviated. In our earlier discussions it will be recalled, that culture was viewed as the embodiment of man's solutions to life's problems. In this sense it is seen as including more than artifactual values.

The second type space summarized by Hurst is social space which is seen as including;

"...the set of spatial arrangements that reflect the social structure, values, and aspirations of a community; it is an important element in any system of social stratification, as when the location of a person's house indicates his social status."

Special attention is drawn to this aspect of space since it is utilized as one of the most basic elements in the creation of an operationalized Total Assessment Profile.

The remaining three types of space discussed by Hurst are ideological, movement, and economic. He views ideological space as symbolizing

...the way in which a community and its relation with other areas is conceptualized....different kinds of ideological space involve different locations for agriculture and industry. Movement space, the perceived part of the environment in which travel generally occurs, is that part of space within which direct stimuli and symbols are presented to the economic decision maker. Finally, economic space may be symbolized in a variety of ways, including the well-known "time-cost dimension", and the numerous measures of economic interaction between groups.

The implications of this behavioral environment for a benefit-cost application become more clear when one realizes that man lives in a symbolic environment and that even physical stimuli are admitted only in symbolic form. In this sense, the symbols acquire social meaning, and circulate between individuals, groups, and generations. Therefore, facts, objects, ideas, etc., that do not enter a person's behavioral environment, similarly will not influence his behavior.

The non-rational basis for a great deal of man's behavior is also embodied in this notion of the behavioral environment. That is, man is non-rational not only in the sense that he spends time groping in uncertainty. But, as Hurst notes, "he also sees around him only a selection of the alternatives that are actually there" [182]. He also concludes with respect to the decision maker that the "...course of actions depends on the values he holds, on his past and present experiences, on the situational feedback, on certain biological and sensory aptitudes, and on an array of symbolic cognitive processes" [182].

11. THE OPERATIONAL MILIEU

As noted earlier, the operational milieu is that area in which activities are carried on. Several factors have been discussed earlier which are part of this milieu. In an earlier discussion it was shown how the various levels of organization constitute this milieu. In a somewhat related conception, Hurst points out that culture, technology, institutions, the political and economic systems are part and parcel of this operational milieu. It is our feeling that this view is somewhat restricted though the idea of the interrelatedness of this milieu is of great importance. The following figure represents our modification of the operational milieu. (Figure 46)

In this view the objective reality confronting man is selectively perceived and organized. Man does not confront each element of objective reality because of biological limitation, physical proximity and a wide variety of other conditioning variables. However, even that part of the behavioral environment which is capable of being perceived and integrated as part of man's virtual space is selectively available and selectively internalized. That is, the operational milieu, shown here as consisting of the relevant cultural background, social systems, institutions, organizations, groups which provide a different set of values, norms, motivations, and resources, operates as a reality filter. Man's view, belief and organization of reality are ultimately the product of his total life experience as it has occurred in and was affected by this series of environmental exposures.

Hurst points out, however, that the operational milieu is an abstraction. It is internalized by individuals and becomes part of their mental set or "black box". This may be clearly seen in Figure 43 shown earlier.

The important implication of this view of man is that it provides a basis for grouping them in a meaningful way. That is, by determining the similarity of virtual spaces—which is the definition of reality governing man's behavior—we are defining groups in a less arbitrary manner. Utilization of money, education or occupation as indicators of man's relative ability to participate in social reality is simply too gross since it doesn't get to the definition of reality which ultimately governs the value, perception, and utilization of these variables. This view is also important in that it illustrates the critical relationship between life exposure and what is possible for any given person. Which cultural values; which institutional exposures; which degree of economic exposure; what technological impacts; etc., are all extremely important questions since they provide the basis for both the differential perception and organization of reality and the availability of further experience, participations and utilization of resources.

Yet, we must return to an earlier statement which becomes increasingly more pertinent to our endeavor. That is, men seek values through

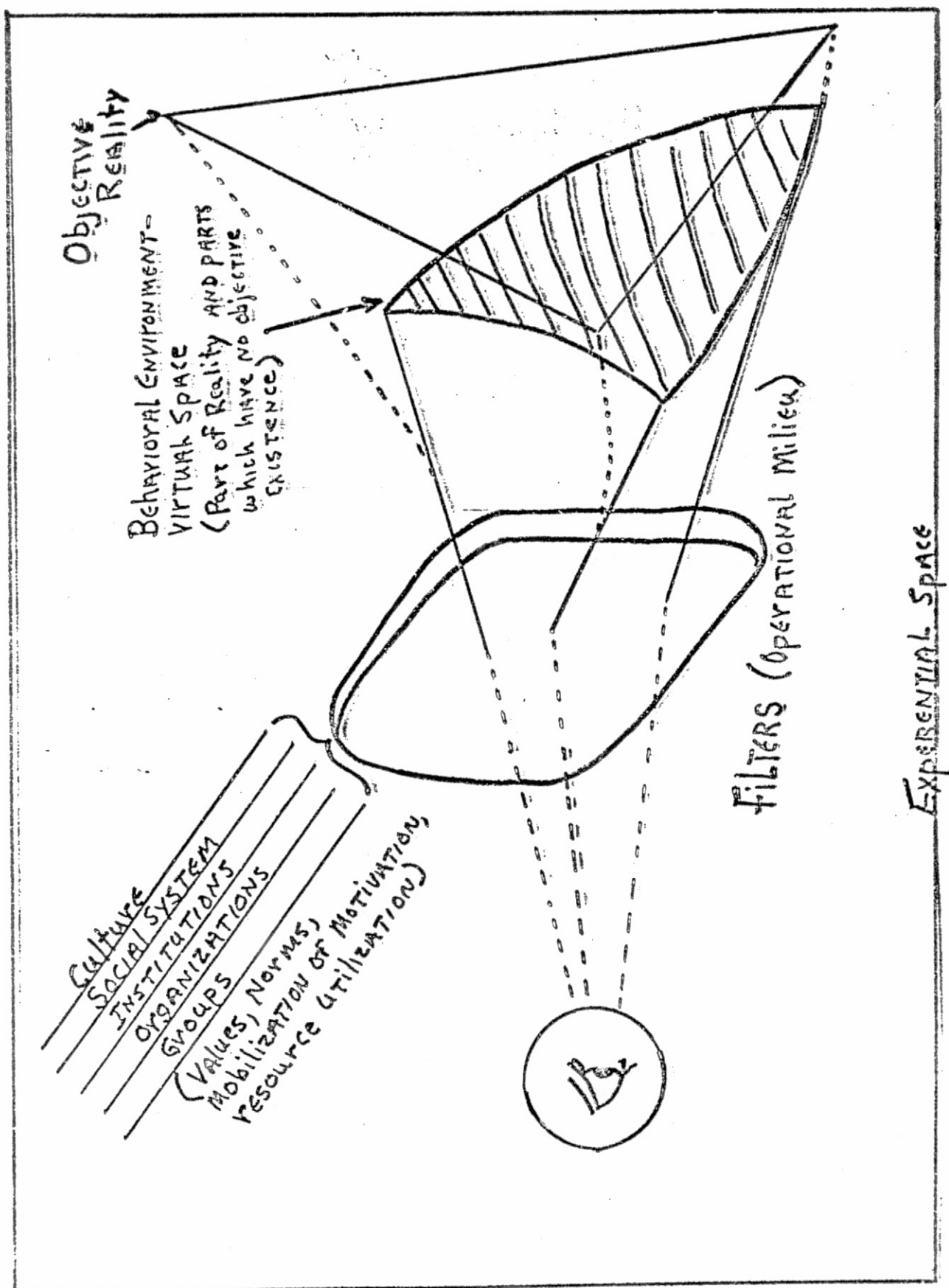


Figure 46.

institutions utilizing resources. Since this holds true for all men, one might logically conclude that examination of the institutions would provide a sufficient basis for examining the relative benefits and costs of a new innovation. However, examination of the obverse of this original statement is sufficient to dispel any such idea. That is, the men who control the resources have an inordinate control over and effect upon the value system since they control the access routes to the institutions. Perhaps, the most dramatic example of this in recent years is found in the conclusion of the Kerner Commission concerning civil disturbances and rioting in the cities. They concluded that the cause was "institutionalized white racism". This doesn't mean that every white man in the society is racist. Rather, it means that blacks and other minorities have been systematically blocked from equal participation because of a lack of accessibility to the institutions in the society.

The point being made with respect to a benefit cost assessment is that depending on the social groups to which a person belongs, accessibility to full institutional participation is more or less available. Hence, when a technology impacts on an institution, the effect is very different in terms of its impact on the various groups of people in the society. The task, therefore, becomes one of determining groups sharing both a high degree of similarity in their virtual spaces and ability to participate in the institutions of a society.

12. SOCIAL PSYCHOLOGICAL PHENOTYPES: DETERMINING SOCIAL GROUPS

In keeping with this general goal just stated, the present approach to benefit-cost analysis outlines a technique for better understanding the differential impacts associated with the introduction of a new technology on the society as a whole, and on the various social groups which make up a society or social system. As very briefly noted, in existing approaches, social impacts are assessed under the notion of socio-economic groupings (SES). In most cases, this measure consists of money. However, in some of the more sophisticated approaches, education, occupation and income provide the social impact base. The present approach expresses the opinion that such analyses are totally inadequate for an accurate assessment of both benefits and costs. The implicit assumption of homogeneity within each of the SES strata is somewhat unwarranted in that cultural, ethnic, age, and a variety of other facets known to influence perceptions, behaviors, and patterns of adjustment are not considered.

The present approach suggests the creation of social psychological phenotypes which more appropriately account for this wide range of variables determining man's organization of, and participation in, the social system. The phenotypes are considered capable of isolating groups in a society on the basis of their differential ability to participate in the social system as reflected in the social demographic and psychological characteristics associated with them. The major thesis is, that

the phenotypes each enjoy a different relationship with the social system. This notion also includes the assumption that men choose where they will live and with whom they will interact on the basis of similarity of values, normative organization of social reality, motivational levels, and the ability to command resources. In this sense, the phenotypes are created around the elements of social action. Specifically, around the way in which these elements are differentially translated into life style. This differential organization has wide ranging implications. For example, as noted earlier, it facilitates or hinders the ability to participate in the processes of the social system. This is especially evident in the differential participatory levels each phenotype enjoys with the institutions of the society, which in turn, has been found to be highly related with the ability to command resources.

The level of confidence we have in the phenotype procedure is based, as noted earlier, on man's propensity to conform. We have already noted that this conformity tends to be collective and instilled in the (over) socialization process. The result of this process is that man shares an established adaptive pattern. This overconformity involves man's response to contemporaneous social norms, self-standards, material interests, emotional needs, and belief system. Hence, the point we would make, is, that through a determination of similarity along these dimensions, as they are reflected in the social and demographic aspects of life style, it is possible to isolate phenotypic groupings which, as we have just noted, enjoy a different relationship with the social system. The end result is better predicting human behavior by being able to assess the relative and perceived impact of change on the various social groupings.

The term phenotype as being used in this approach is derived from the work of Kurt Lewin and is contrasted with genotype. Genotype is generally thought of as a biological referent related to genes and their relationship to human growth and development. Lewin used the term in a slightly different fashion using it to refer to the immediate perceptible appearance of a person. In the present approach we are making the assumption that genotypes are randomly distributed in the environment. Phenotype as its being used here refers to behavioral consistencies in the individual that are accessible to observation. These consistencies are shared by others within the groups and are understood by the community. They are also accessible to investigators and provide a basis for making inferences about the underlying behavioral dispositions. The important question becomes one of determining the stability of these behavioral consistencies and their effect on the course of human adaptation. Robert Levine [183] suggests that while change is part of man's reality, the potential for prediction of human behavior grows out of the propensity of men to over-conform. He notes:

"Overdetermination can be seen as a conservative force because individuals tend to be oversocialized; they are wedded to an established adaptive pattern through multiple motives and pressures acting at different points in their development toward a convergent effect. The result is what might be called 'overconformity', in which the individual's

conformity is in response to contemporaneous social norms and his own inner standards and his own material interests and his emotional needs and an institutionalized ideological system - all converging in the same phenotypic behavior." [183]

The actual process of establishing the phenotypes is discussed later in this volume.

13. CONCLUDING REMARKS

At this point, it will be helpful, if we summarize what has been covered to this time. As a first step toward creating a more accurate estimate of both the benefits and costs for implementing a new technology, we have focused on the social sciences. Our position is that economics in its current state provides us with a very poor reflection of man's social reality. In order to assess both benefits and costs one must understand more of the complex dynamics involved in social reality. In attempting to provide some insight into this process, we have focused on the nature of man himself suggesting that one way of understanding the complexity is through the systems analogy. Specifically, we wish to draw attention to the social nature of man, for while a great deal of man's capabilities and capacities are determined by biology including heredity, an even larger part is acquired in the process of interacting with his fellow man, situations, and events. This interaction is additionally qualified by other conditions which are present either physically or as past and future conditions. Man as an interactive being is involved in a continual process of dealing with reality. However, the reality an individual person confronts is not necessarily the same reality other persons confront. Hence, to gain the certitude or predictability necessary for action, man, through interaction, confirms or validates his reality. In this process he does to some extent recreate reality. Thus, while there is an objective reality in an existence sense, the reality of individuals is to some degree different. Subsequently the acts of individuals may be expected to be somewhat different depending on the particular manner in which the individual interprets his or her reality. On the surface this would suggest the conclusion that prediction with respect to human behavior is nearly - if indeed not - entirely impossible. However, there is reason to suggest that this is not entirely the case.

We have shown, man interprets his reality in concert with others. Those "others" are most often those sharing similar values, beliefs, levels of motivation, and ability to command resources. They are also most likely to enjoy a similar level of participation in the institutions of the society which ultimately spells out their relative ability to command goods and services offered in the social systems. Hence, there is activity on the part of humans, but also a feedback effect which acts as a subsequent facilitator or inhibitor for that action. It is the similarity of this participation and organization of reality that provides a basis for determining the various social groupings in a society.

Thus, by examining the collective dynamics which operate within and between these various social groupings, the scientist is able to come much closer to predicting human group responses. That is, through collective action, by viewing both the components of social action and the processes articulating those elements, one can arrive at a better understanding and prediction of human social behavior. By clustering the dimensions that reflect differentials in social action one determines what we have called social psychological phenotypes.

X. CURRENT APPLICATIONS USING PHENOTYPES: HAZARD PERCEPTION AND MARKET RESEARCH

1. INTRODUCTION

The use of phenotypes has been used in some on going research. However, the term phenotype has not necessarily been used. Generally, the emphasis has been on isolation of social groups. The utility of this concept is implied in the definition of a group. Specifically, that a group displays a unique pattern of behavior. It is the common behavioral pattern that may ultimately be the best group definition of group homogeneity. This uniform patterning of behavior suggests a common set of historical, life style and demographic variables. Family locational proximity and education (both formal and informal) are thought to be responsible for similarities in behavioral pattern. Although such behavior patterns change during a person's life cycle, the range of deviation from the norm may be consistent for that group. Radical deviations may occur in a few traits but the strength of early training still wields a strong common bond with the unique behavior patterns central to that group. In fact, departures from the norm may contribute feelings of discomfort to a spatially or socially displaced member. In the literature, social scientists have recognized that the common bond for a group is a psychologically oriented set of shared experiences. Common behavioral responses, then, result from shared cognitive mapping programs, shared in the sense that similarities in thought patterns reflect close associations with formal and informal educational experiences common to that group [184]. Such cognitive patterns may represent the only known social or emotional response to a commonly recognized stimulus. As noted earlier, this set of knowledge responsible for the behavioral patterns is referred to as the behavioral environment. The commonality in the groups behavioral response is a function of sharedness in what we have called earlier the virtual space.

The major problem in getting at the uniqueness of behavioral patterning is, of course, determining which elements in the social life experience of the group control or predict the construction of the cognitive based controlling the behavior. In this endeavor, the majority of social scientists have used some measure of socioeconomic status. For the most part, the results have been considerably less than adequate. It will be recalled that this has been one of our consistent themes to this point. That is, that socioeconomic status -- generally comprised of educational level, occupation and income -- is too incomplete as a predictor of how man participates or of his ability to participate in the society. Yet, the

reality of homogeneous groups of persons sharing unique patterns of behavior cannot be denied. The problem of the social scientist, therefore, is one of determining the best combination of factors common to the group which provides both a basis for isolating the groups and predicting their most probable course of action in relation to events.

2. HAZARD PERCEPTION

Since the task underlying the development of the present endeavor concerned the implementation of an early warning disaster satellite, attention was given the literature dealing with natural disasters. Of prime concern in this review is the link between relevant attitudes or perceptions and actual behavior at a variety of periods during the hazard situation and also during safe or non-critical periods.

The National Hazard Research program grew, out of the flood basin studies started at the University of Chicago in 1956. The formal program began in 1967 with financial support from the National Science Foundation and subsequently was transferred from Chicago to the University of Colorado. The eventual structure of the program became a collaborative effort between Colorado, Clark University and the University of Toronto. [185] The publications produced by this investigative group comprise one of the most comprehensive collections of recent material about human behavior in hazard situations. Many field investigations in several countries are reported but there are few important contributions to theory. [186] In addition, bibliographic searches have accumulated a wide variety of relevant material. [187,188]

The major emphasis of this research effort is the manner in which man perceives extreme natural events and his ability to adjust to their occurrence. Approximately 32 projects were funded for investigation by 28 participants in 16 countries. [189] A variety of natural hazards were included: avalanche, coastal erosion, drought, earthquake, flood, snow, hurricane or tropical cyclone, volcano, wind, frost, landslide and tornado. These field studies were preceded by the initiation of new lines of study the preparation of research instruments and the undertaking of pilot investigations. Research results have been presented in a working paper series, several journal articles, and various academic meetings, one of which was the Calgary, Alberta meeting that provided the most recently published set of papers. [190]

An investigation of behavioral correlates of social groups constitutes one of the primary objectives of this hazard research. Behavioral responses to hazard situations are regarded as personal adjustments to threat, largely to its perceived severity and frequency. Such personal adjustments vary spatially in correspondence with nature of the hazards, or hazards, prevailing in different areas. Adjustments, then, are viewed as functions of both individual and group perceptions.

Two major objectives have informed the majority of this research.

1. Determination of the range of possible adjustments by social groups to these extreme events.

2. Examination of how people perceive the extreme events and resultant hazard.

In the first of these objectives part of the task is concerned with the isolation and determination of groups. In the present endeavor we are concerned with this same process and have, therefore, included the following findings. In so far as hazards are concerned, variables common to a group such as socioeconomic status and age fail to predict hazard perception and estimation [191]. However, choice of adjustment to a hazard is concerned with such indicators. In a study by Kates [322] the choice of adjustment had been found to be significantly related to resource use. Kates is also concerned with showing the effect of hazards on the decision-making process. He found that personality characteristics including attitudes and opinions toward fate and nature, tolerance of dissonance and risk-taking propensity, are highly related with the perception of hazards and adjustment behaviors. Social scientists have noted for a long time the strong relationship between social class and these type perceptions. However, Kates does not make the connection directly. Rather, he notes that in addition to personality factors attributes such as general access to communication networks and unique role responsibilities and training are important. Of course, these attributes are directly related to socioeconomic status.

Baker and Patton [192] found several positive correlations between socioeconomic status and attitudes of persons living in low, intermediate and high hazard risk areas. The most significant correlations were with site, income, age, and literacy. However, it must be noted that in the Calgary meetings discussed earlier, socioeconomic and social demographic variables were not considered as strong indicators or predictors of adjustment. However, a strong assumption of their relationships still exists among social scientists. Several investigators have suggested combinations of demographic, attitude and personality variables for group identification. The complexity of these interrelationship is recognized and the use of a simple test instrument in field studies may be operationally naive. White states that, "There are slight but provocative grounds for expecting that the stated attitudes would vary in some degree with length and type of the respondent's experience with stream and mesa, that perception of severity would vary with social status, and that propensity to act would be related to role identification and affective complexity." [193] In reviewing many of the flood hazard reports there often is the feeling that the data were capable of more intensive analysis, that different quantitative methods might have yielded results more accurately testing some of White's hypotheses.

Other papers which reported some interesting findings with demographic variables and social groups were the following. In assessing adjustments to wind in Boulder, Colorado, Miller, Brinkmann and Barry found six variables to be statistically significant: location within the city, severity, the number of years lived in a specific home, the acceptance of a means of prediction, the type of home and relative annual income. [194] Murton and Shimabukuro learned that perception of volcanic activity correlates significantly with age and length of residence, which

reflect experience in coping with this hazard. [195] Earney and Knowles included demographic variables in constructing a scale which was used to explain differences in the sets of adjustments listed by respondents. [196] Rowntree divided a community into several culture groups to analyze differences in their evaluation by coastal erosion. It is interesting to note that groups were delimited by value systems as suggested by meanings given to the concept of coastal erosion.

While these studies of hazard perception fail to provide any conclusive evidence as to the use of socioeconomic status for predicting adjustment behavior. It is our belief that the dependent variable, in this case hazard perception, is such a unique and peculiar variable that prediction by groups might well be nearly impossible given the existing techniques to measure unique and somewhat idiosyncratic events. However, the spatial dimension emerges as a very important dimension and one that has been found to have very definite socioeconomic status and social demographic implications.

3. MARKETING

While the term "phenotypes" is not traditionally utilized in the marketing profession, much of the technical procedure is geared toward identifying groups of persons who qualify as phenotypes as the term is employed in this work. This similarity is found in the problem of identifying how various groupings will respond to "new" products.

The key to identifying differential market responses lies in the understanding of notions like "markets", "market segmentation", "innovation", "the diffusion process" and "the adoption process".

MARKET

A market according to Stanton [197] is defined as people with needs to satisfy, money to spend, and the willingness to spend it. In defining the demand of a market for a given product or service, there are three factors to consider: needs, purchasing power and buying behavior. A need has been defined in a marketing sense by Tillman and Kirkpatrick [198] as the opportunity to protect or enhance one's self-concept; it is a feeling of inadequacy, a chance to enhance one's image of one's self, or a threat to one's self-image. The second of these concepts, purchasing power, is defined by Stanton [197] as personal income (gross income before taxes), disposable personal income (money remaining after taxes), or discretionary income (disposable income less (1) essential expenditures for food, clothing, household utilities, and local transportation and (2) fixed expenditures for rent, house mortgage payments, insurance, and installment debt payments). The third element, buyer behavior, is defined by Engel, Kollat, and Blackwell [199] as the acts of individuals directly involved in obtaining (exchanging money or a money substitute) for economic

goods and services and the decision process that precedes and determines these acts. All three aspects are importantly related in the identification of portions of the market called market segments. In the sale of particular products marketing experts have found that few products have universal appeal. Thus they have been forced to identify parts or segments of the total market to which the product will appeal.

MARKET SEGMENTATION

Stanton [197] notes that market segmentation is the process of taking the total, heterogeneous market for a product and dividing it into several submarkets or segments each of which tends to be homogeneous in all significant aspects. The firm that adheres to a strategy of segmentation faces several demand schedules — a separate one for each market segment — and tailors its products, prices, promotions and channels of distribution for each segment. This concept, if carried to its logical extreme, would result in a market segment represented by a single individual which, of course, is not at all useful for marketing. In marketing the danger is to appeal to a market segment that is too limited, one that is too small to support the marketing activities directed at it. On the other hand, market aggregation, is the process of taking an individual and/or a group of individuals, homogeneous in all aspects, and grouping them (individual or group) with another individual or group of individuals also homogeneous in all significant into a more heterogeneous grouping. According to Claycamp and Massey [200] the firm that adheres to a strategy of aggregation faces one demand schedule and fashions its product, price, promotion and channel of distribution to appeal to anyone and everyone. The danger in this case is to appeal to a market aggregate that is too broad, one that is so wide that no member of the aggregation realizes that marketing activities are being directed at an aggregation of which he is a member.

MARKET GRID

McCarthy [201] suggests using grids to isolate all or at least most of the possible variations among market segments/aggregates. This process is illustrated in the following figure by McCarthy. Market grids represent homogeneous market segments/aggregates as combinations of relevant market characteristics, relevant to the needs of the present and/or potential customers constituting that same segment/aggregate as illustrated in Figure 47 by McCarthy.

The refrigeration market is an excellent example of the grid concept. Refrigeration is needed by many different types of customers. These customers do not all want the same product, and geographically are unequally accessible. The refrigeration requirements of each type of customer, can be analyzed further. As shown in Figure 48 the food store's requirements

Market grid for a product-need area

		Potential target markets		

Figure 47. Market Grid. Source: McCarthy [201]

Market grid for refrigeration

East	Midwest	South	Moun- tain	Pacific	Region Piece of use
					Home
X					Food Stores
					Wholesalers
					Restaurants
					Hospitals
					Schools
					Military Reservations
					Business Offices
					Other In- stitutions
					Trailers
					Picnics
					Planes
					Trains
					Ships

Figure 48. A Market Segment/Aggregate. Source: McCarthy [201]

for example, are dependent on the size of the store and the type of products needing refrigeration.

Market grid for refrigeration in eastern food store market

Large Stores	Medium Stores	Small Stores	Size Type
			Fruit and Vegetables
			Dairy
			Fish
			Meat
			Full-line Groceries

Figure 49. Refrigeration Market Grid. Source: McCarthy [201].

A household's requirements are dependent on its size (number of members). Constraining the attainment of these requirements are the household's income, and attitude toward refrigeration.

Each market grid box should be thought of as a separate market (market segment). The size of the box can be made to reflect the potential sales of that market. If several of the smaller individualized markets can be satisfied by a single product, market aggregates can be served. On the other hand, if the variations in refrigeration demanded by each market are very great, and these markets are not very large, it may be difficult or unprofitable for a particular firm to go after the business represented by these boxes. In such cases according to McCarthy [201], the markets may go unsupplied or at best "make do" with products not specifically intended for them.

BUYER BEHAVIOR

The process of building market segments/aggregates is grounded in the theory of buyer behavior: what, where, when and how people buy.

Theories of buyer behavior depend on the assumption that the consumer's behavior is an organized and meaningful response to the world as seen by the consumer. In our earlier treatment of the perceptual element of man we spoke of this subjective definition of the world or social reality as "virtual space". Each consumer's virtual space (perceptual field) includes several aspects. We discussed all that's included earlier as elements of the behavioral environment. Others treating the phenomenon as a perceptual field note that the field includes the persons physical self, his surroundings, awareness of family social class, culture and the concepts he has acquired about all of these over the course of his lifetime up to the given instant of behavior. This process is nicely accounted for in the system's view of man Kuhn created. This systems view (discussed earlier) helps to bring out the existential nature of man and the implications of that nature for present behavior. That is, man has a past, present and future, all of which coalesce to affect the behavior of the present moment.

The self-concept is also dependent on this threefold aspect of man's life. The self-concept which is part of man's virtual space, refers to all the perceptions a person has of himself at a given point. It is himself as he sees himself. This view is a multifaceted one involving dimensions of a physical, social, and moral nature, along with time perceptions of past, present and future. It also includes others who have differential levels of significance for the person and the perception of externalities.

MARKETING NEEDS

One of the major behavioral assumptions underlying marketing techniques as they are being used today is, given the images people have of themselves, they try to maintain and/or enhance them. As they encounter externalities, they ask, "Am I doing everything possible to protect and/or enhance my self-image?" If the answer is no, they feel a tension or need. Hence, a need is defined as tension that results from the perception that the individual is not doing everything possible to protect or enhance his self-image. As is shown in the following illustration, the realization that one is not

NEED → GOAL → PURCHASE → REINFORCEMENT

doing everything possible to protect and/or enhance one's self-image, results in the selection of alternatives aimed at restoring one's self-image to a state of equilibrium. Treating behavior as need-driven results in a tension reduction model of consumer behavior. As may be seen in the following illustrations, goals are chosen in terms of their ability to reduce these need tensions. Satisfaction/dissatisfaction exists to the extent the goals are successful/unsuccessful in accomplishing this objective.

TENSION REDUCTION MODEL OF BEHAVIOR

GOALS ARE CHOSEN IN TERMS OF THEIR ABILITY TO REDUCE TENSION

SATISFACTION - REDUCTION OF TENSION

DISSATISFACTION - TENSION NOT REDUCED OR INCREASED

PRODUCT

To this point we have been emphasizing market needs and requirements. We would like to shift attention now to the notion of a product. Products have been descriptively defined so as to include the following ideas: products are symbols; products are the satisfactions they are perceived to be; people use products to reflect themselves, to show others who they are and what they are; they express values. Stanton [197] defines a product or service as a satisfier of needs and/or requirements. A product is the complex set of tangible and intangible attributes that offer satisfaction of wants and needs. The key idea in this definition is that the consumer is buying more than a set of chemical and physical attributes. Fundamentally, he is buying want satisfaction. Stanton also notes he is buying the product's benefits (what the product can do) as well as buying a psychological symbol (reflection) of personal attributes, goals and social patterns (what the product means). In the sense that a need is an opportunity to protect or enhance one's self-concept, by satisfying one's needs, products reinforce that person's self-image.

As may be readily seen from this discussion the basis for phenotypes resides in the same theoretical notions. As we progress now to show how marketing is currently utilizing this theory to segment markets and doing so successfully, it will become more apparent why we are stressing movement toward determining social groupings on the basis of their total life experience rather than some limited economic figure. However, prior to delving deeply into the techniques of market segmentation we are going to discuss another important theoretical facet of marketing — relevance.

RELEVANCE

Marketing's objective is to make stimuli as relevant as possible; the closer the stimulus is to one's self-image, the more likely it will be need generating, and the more likely it will generate behavior. Herein lies one of the greatest advantages and potential harms to society, that is, the creation or inducement of needs. For several years social scientists have studied the effect of opening new institutional opportunities to groups who had not participated in them. They spoke of the "rising tide of expectations" to explain the surge of need behavior and attendant disillusionment associated with not being able to attain what was held out for "all to enjoy".

If individuals "buy into" or formulate their self-image around things or products rather than their intrinsic or inherent worth as human beings,

then it is quite possible that the society can expect to experience a dramatic rise in maladjusted behavior. This is especially so, since material products are in most instances transient, tangible phenomena of little intrinsic worth. Their worth is imputed and will quickly diminish as they fail to produce the self-satisfactions promised by the marketing literature. We will address this aspect in greater detail later.

The immediate relevance of a product may be shown through an examination of the process of determining what is relevant. Relevance is fairly easy to define because the values people learn, the perceptions they hold of themselves and the perceptions they hold toward externalities are learned in terms of what others (within their virtual space) value, and in terms of how others in their "space" perceive them and perceive externalities. In turn, people surround themselves with, feel more compatible with, people who hold values and "see" the world in ways that are similar with the values they hold and the world perceptions they have.

GENERALIZATION-DISCRIMINATION

A final element considered under the notion of buyer behavior deals with the relationship between the relevance of the product and size of the market segment. The relationship is graphically shown in Figure 50. There is, as shown, a curvilinear relationship between relevances and

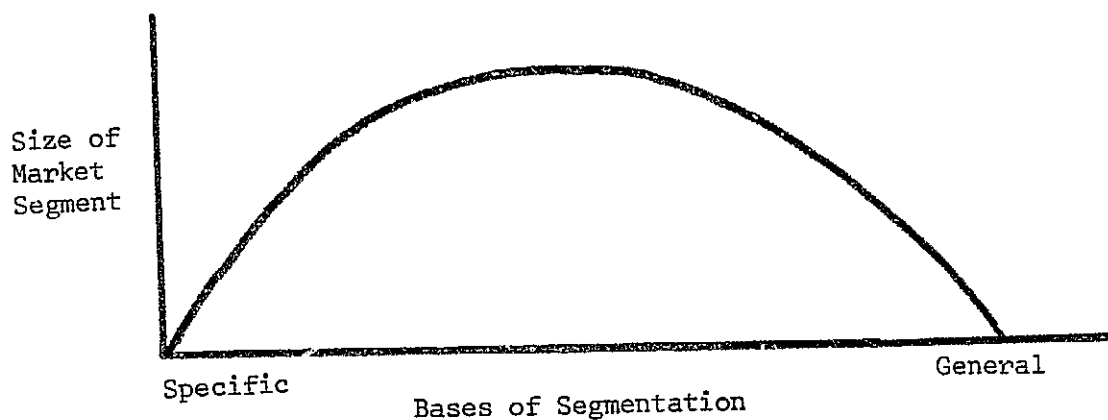


Figure 50. Relationship of Market Segment Size and Product Relevance.

market segment size. The finer the discrimination desired, the smaller the segment reached; the greater the generalization accepted, the smaller the segment reached. Thus, as a product moves toward extreme relevance, only a few persons may be reached as the others fail to see the relevance

of the stimulus to them. The other extreme presents a situation where because of extreme generality, the product is relevant to only a few as the majority of people fail to see the relevance of the stimulus to them. The basis for segmenting the market, therefore, defines the size of the market.

The segmentation process has employed variables such as, demographic characteristics including sex, age, life cycle, racial and ethnic sub-cultures and geographic location; socioeconomic characteristics like social class; and personality and life style characteristics.

Frank, Massey and Wind [202] discuss the segmentation variables noting that the most often used include those just discussed. They feel that the demographic variables have not been particularly useful in segmentation studies with respect to buying behavior. They find the life cycle indicators consisting of a composite of demographic characteristics like marital status, age, presence and age of children, and age of housewife to be better predicting buying behavior. However, not all studies have yielded positive results in this regard either. Subcultures tend to be homogeneous with respect to the more global and philosophical definitions of man and yet with respect to buying behavior they do not accurately define the segments according to Frank, et. al [202]. However, racial and ethnic bases are found to offer a good basis for the buying of food items, but not non-food items.

Geographic location and mobility has been shown to be a good basis for demonstrating differences in consumption behavior. There are two general principals underlying this approach to segmentation: (1) patterns are found in the distribution of populations, and (2) the notion that each location develops its own "culture" and hence may have different behavioral patterns.

The socioeconomic status indicators have also become a popular basis for segmentation with respect to buyer behavior. Generally, the socioeconomic indicators include measures of education, occupation and income. Income has also been used as a variable by itself. Frank, et. al [202] note there are four measurement issues involved which may be summarized in the following questions.

1. The determination of the relevant unit of analysis. What is the most appropriate measure of income — per capita, per receiver, per household, per family, or per spending unit?
2. What type of income is to be included? Usually only salaries, profits, dividends, and interest received are included as income. Should one include other nonmonetary income equivalents, such as food grown in one's own garden, furniture built by the husband, and the like? Should one include income before taxes or consider only

discretionary income? Still another issue concerning the type of income is whether to attempt to measure a consumer's transitory or permanent income.

3. What are the nature and extent of the relationship between income, wealth, and credit potential and one's ability to purchase? Given that there is less than a perfect correlation between the three components of ability to buy, should one design a combined measure of ability to purchase?
4. What are the extent and nature of regional differences in income level and distribution? Since \$5000 in a small rural area may buy much more than the same amount in New York City, what adjustments should be made in assessing the income level of persons in various areas?

They also note that to this point the problems raised by these questions have not been resolved.

Social class is also used as a basis for segmentation. Classes tend to be relatively permanent, substantial, homogeneous divisions in society with similar values, interests, life styles, and behavior patterns. In the present study we are utilizing the term phenotype to refer to this type similarity. However, we are involving a wider number of factors felt to be important with respect to ability to participate in the society including psychological variables. The psychological variables felt to be important since they condition the perception of and response to the other social class dimensions. For example, the perception of \$5000.00 will be very different to persons within the same general social strata and very much so between the various strata. A truck driver and a college professor in present day America may have the same income level. Yet, their perceptions and utilization of the income will be very different. This may also be seen in the psychological differences between two social classes. Figure 51 presents a graphic depiction of just such differences.

Given the important stress marketing has placed on "relevance" it is little wonder that personality and life-style characteristics have been the basis of many segmentation attempts. However, use of existing personality inventories have been relatively unsuccessful in predicting buyer behavior or segmenting a market. Kassarian, [203] suggests two reasons for the fact that general personality measures can explain only 10 per cent of the differences in behavior among segments. First measures developed to determine deviance are being used to predict market behavior. Second, personality can not explain more than 10 per cent of the variation in behavior among segments because the majority of the variation can be explained by demographic variables.

Somewhat more successful among the psychological and personality based approaches are those using semantic differential similar to the one presented in Figure 52. Using this type scale consumers of a specific brand product have been found to hold self-concepts similar to the self-

PSYCHOLOGICAL DIFFERENCES BETWEEN TWO SOCIAL CLASSES	
Middle Class	Lower Class
1. Pointed to the future	1. Pointed to the present and past
2. Viewpoint embraces a long expanse in time	2. Lives and thinks in a short expanse of time
3. More urban in identification	3. More rural in identification
4. Stresses rationality	4. Nonrational essentially
5. Has a well-structured sense of the universe	5. Has vague, unclear, and unstructured sense of the world
6. Horizons vastly extended or not limited	6. Horizons sharply defined and limited
7. Greater sense of choice making	7. Limited sense of choice making
8. Self-confident, willing to take risks	8. Very much concerned with security
9. Immaterial and abstract in his thinking	9. Concrete and perceptive in his thinking
10. Sees himself tied to national happenings	10. World revolves around family and self

Figure 51. Psychological Class Comparisons. Source: [203]

concepts they attribute to other consumers of the same brand and consumers of a specific brand have been found to hold self-concepts significantly different from self-concepts they attribute to consumers of competing brands. Similarly, a high degree of congruency between perception of self and one's perception of liked products has been observed.

A final dimension currently employed as a marketing segmentation dimension is the concept of life style. The assumption that people use

Concept to be evaluated:

reliable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	unreliable
weak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	strong
clean	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	dirty
superior	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	inferior
stable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	changeable
active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	passive
unsophisticated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	sophisticated
distasteful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	tasty
colorful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	drab
dull	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	exciting

Figure 52. Sample Semantic Differential Scale

products to reflect themselves to others is changed in this procedure to products that can be used as reflections of people. That is, product assortments can be used as reflections of a person's characteristic way of living or responding to his environment. For example, to say that a person is economy, socially, innovation, safety and/or family oriented based on the person's product assortment, is to say something unique and distinctive about that person.

The use of life style as a basis or segmentation is conceptually appealing, and when expressed as the combination of activities, interests, opinions, values, and products that describe a person holds a great deal of promise for creating market segments. This life style — gestalt method — of segmenting markets lends considerable credence to the phenotypic procedures employed in the Total Assessment Profile.

XI. SPATIAL CONSIDERATIONS OF PHENOTYPIC BEHAVIOR

1. INTRODUCTION

Both the hazard perception and market segmentation approaches to phenotypic behavior are limited ones, in that they are built around the notion of predicting behavioral responses to a particular class of phenomena or product. While some degree of success has been achieved in both areas, the approaches remain incomplete and largely devoid of theory. Yet, a considerable body of theory has been created which deals with phenotypic behavioral responses. One important set of findings with respect to phenotypic differentials has been demonstrated in examinations of the perception of information flows and interactions over space. On the basis of such differentials there is every reason to believe that the innovation of new technology over large regional areas will reflect both variability in its acceptance and utilization by local phenotypic groups. Hence, insight into the spatial behavior of phenotypes in terms of the communication process provides a valuable starting point for creating an operational model. We are initially interested in explaining the implications of human information flows and fields as they relate to the manifestation of areal differentiation and interaction of various phenotypic groups. To this point, the application of information theory has been limited by the lack of adequate human interaction data. The operationalization of the model proposed in this study is, in fact, dependent upon the acquisition of data for a sufficient number of variables which is most likely dependent on survey research.

The theory of Richard Meier [204] provides an initial framework for utilization of information theory in a spatial context. The model constructed in this study expands Meier's initial observations by introducing a more rigorous treatment of space. The emission and absorption of informational units as they are related to their quantity and quality are thus being evaluated in a spatial framework.

2. BASIC CONCEPTS OF COMMUNICATION AND SPACE

Meier [204] believes that the aggregation of populations in space is based on the need for direct human interaction. Based on this hypothesis, one may view a regional growth process as a compounding system of human bonds facilitated by means of a highly connected communication system. Establishment of threshold levels of interlocking roles provides permanency to the existence of a community which in turn generates continued expansion of linkages between individual members. Urban growth, for example, is a process by which new informational links are produced more rapidly than attrition, obsolescence, and interference of the existing linkages. As several scientists have noted [205,206,207], the more complex and interrelated the sociological and economic bonds between groups of individuals the greater will be the survival capacity of the entire system.

The collection of information, its storage, and its interrelationships are viewed as cultural growth when accumulation outstrips dissipation rates. The relationship between cultural growth and economic growth is a key element in an explanation of a developing regional system. Meier [204] notes that cultural growth is believed to precede economic growth. A time lag of more than ten years may occur between the actual commitment of capital to an innovation and the per capita economic returns resulting from the invested capital. The communication network performs a dual function of supplying adequate internal and external information flows conducive to innovation and then creating the motivation behind the demand for the results of the innovation. Pred's [208,209] regional growth model illustrates the relationship between the innovation process and regional growth. A similar recognition of the innovation element as a facet of economic growth is noted by James Green and Robert Steiner [210,211] in their respective urban models. Machlup [212] points out that the effectiveness of the communication system's transmission of internal and external information flows determines to a significant degree the capacity for formulation and perpetuation of structural bonds.

An exploration into the character and structure of human interaction in a spatial context provides the initial framework for construction of a communications model. Meier observes as shown in Figure 53, that the frequency of interaction between individuals declines with increases in

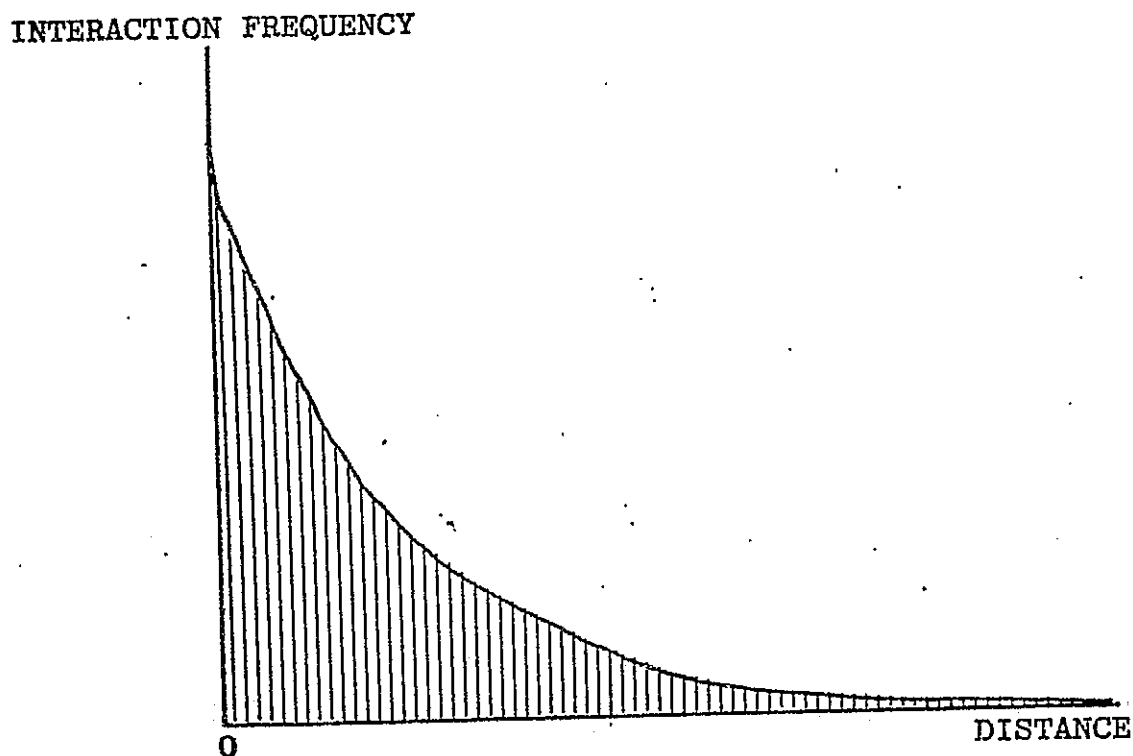


Figure 53. Distance and Communication Interaction

distance. In a more realistic representation of the concept portrayed in Figure 53 we would expect some locations on the distance axis to be emitting information at such an intensity that the distance decay function would not be fully operative in absorbing the information flow. The result of this case would be to impart on the generally smooth curve of Figure 53 a series of fluctuations which would indicate emission centers of high and low intensity. The general configuration of the curve depicted in Figure 53 is valid, however, it should be recognized that the slope of the curve would vary with individual members or groups. People associated with groups characterized by high levels of economic and social attainment would be expected to have greater spatial interaction and perception.

A treatment of the individual's action space (immediate subjective environment) may be observed in the works of Webber [213], Cox [214], Downs [215], and Moore [216] in which the level of spatial perception and interaction is found to vary with the individuals socioeconomic level. Webber's approach to the quantity of spatial perception and interaction at various levels of individual specialization is demonstrated in the following figure. This figure illustrates the notion that as an individual's level of specialization (a function of his socioeconomic level) increases, his perception and interaction over space increases. Increased spatial interaction is demonstrated in Figure 54 as a series of uninterrupted lines which characterizes those persons found at the higher levels of individual specialization.

LEVEL OF INDIVIDUAL SPECIALIZATION

HIGH

LOW

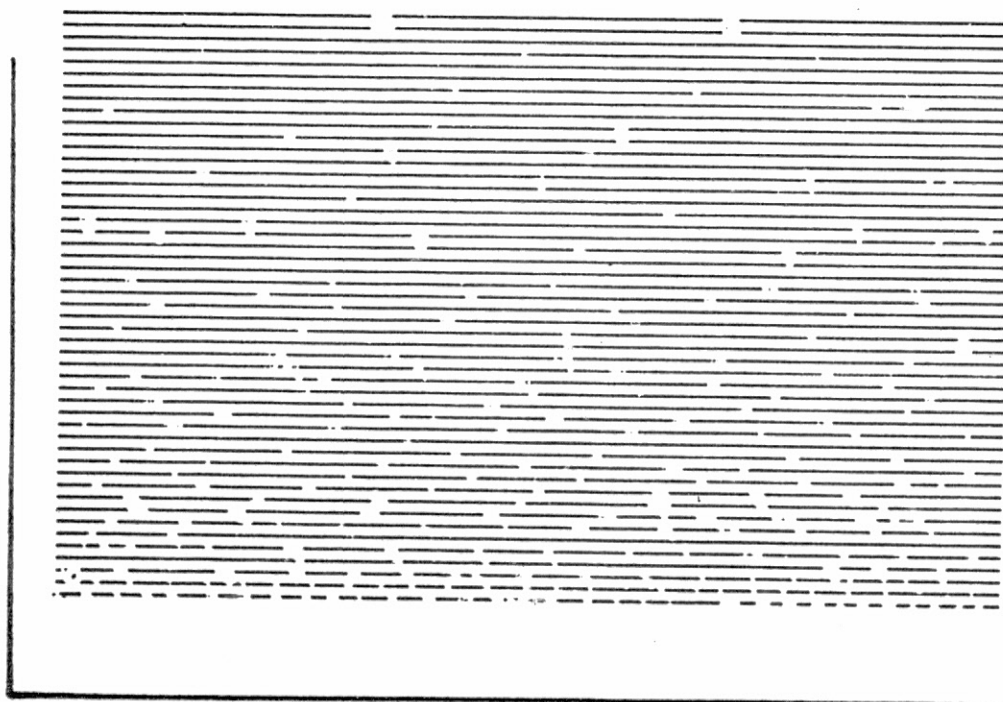


Figure 54. Levels of Individual Specialization and Interactions Over Space. Source: Webber [213].

PERCEPTION AND INTERACTION
OVER SPACE

Incorporation of the above observations into Figure 53 results in a modification which is more sensitive to individual levels of spatial perception. Figure 55 represents the modified version which includes a series of curves having different slopes. The various curves are representative of people or groups at different levels of specialization. It may be noted from this diagram that at short distances interaction rates decrease at about the same rate for all individuals. Increased distance results in a separation of the curves with the more specialized individuals experiencing greater scope in their interactions over space. It may be observed in the diagram that persons at lower socioeconomic levels experience a more abrupt decrease in the spatial extent of their informational fields.

INTERACTION FREQUENCY

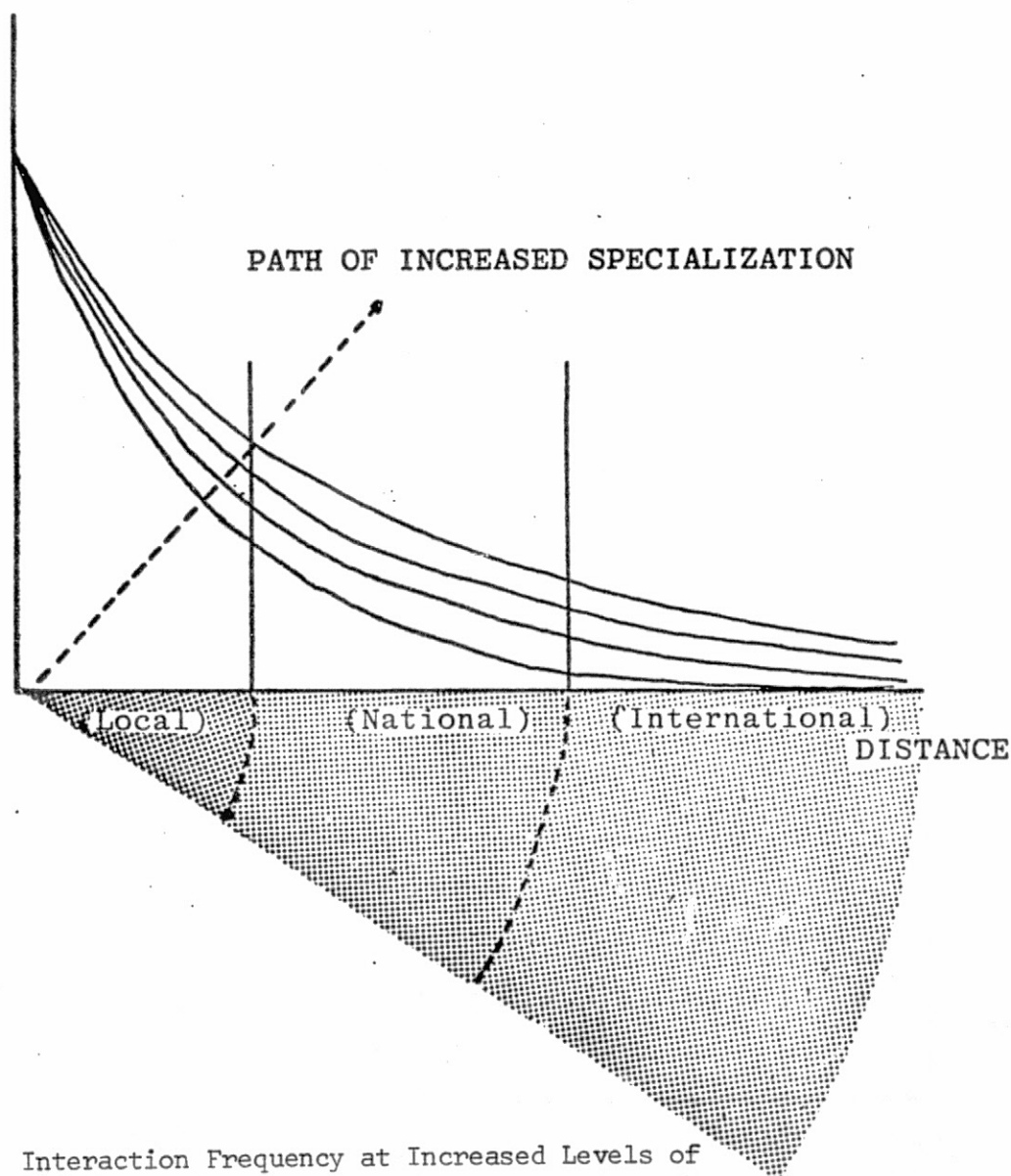


Figure 55. Interaction Frequency at Increased Levels of Specialization Over Space

Meier demonstrates that human contact results in both attraction and repulsion which become a function of the frequency of human interaction. Figure 56 illustrates this concept. In this figure it can be seen that contact initially leads to cohesion, however, contact to the point of saturation (invasion of personal space) results in repulsion. An analogy based on economic theory may be noted in the advantages of

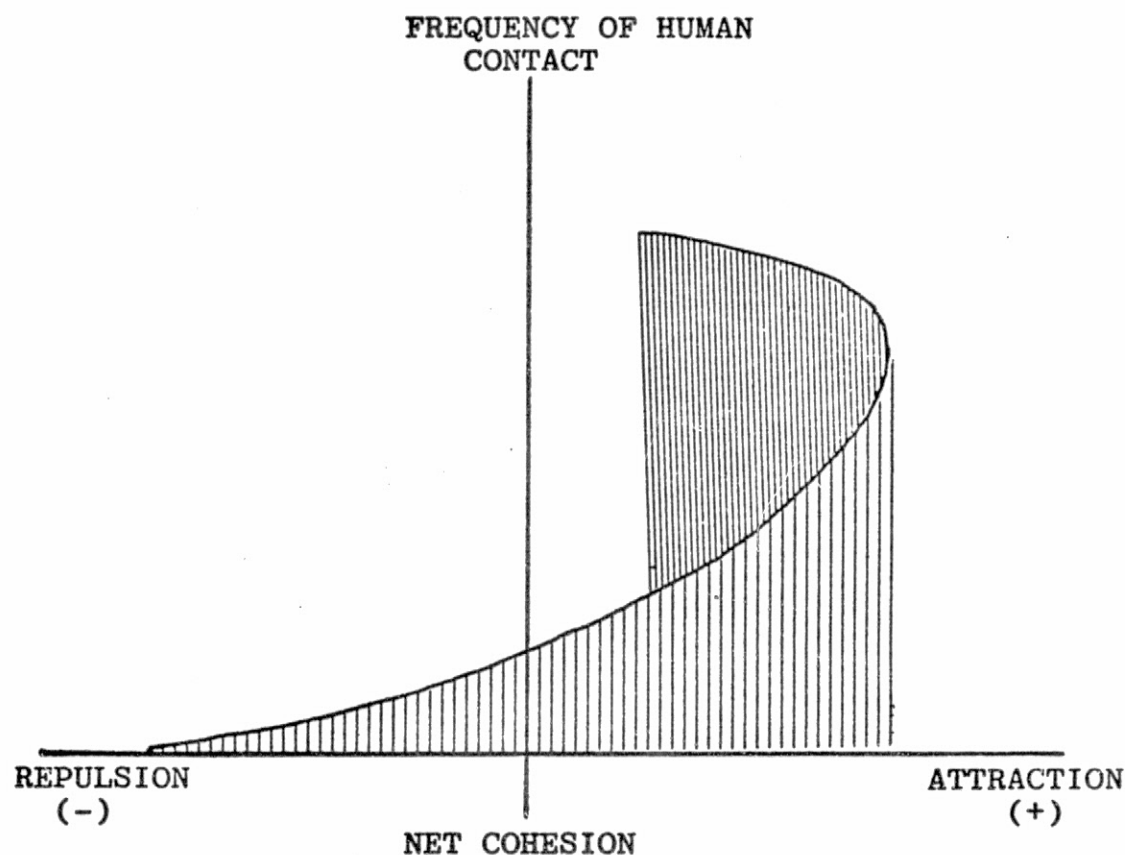


Figure 56. Net Cohesion and the Frequency of Human Contacts
Source: Meier [204]

agglomeration (economies of locational integration), in which continued spatial concentration eventually leads to spatial diseconomies and a centrifugal disaggregation of the complex. The conditions noted in Figure 56 reappear in a slightly different context when distance is included as a variable. Figure 57 depicts the curve of attraction and repulsion as a function of distance. Initially, because of the basic desire for privacy, we note that repulsion exists at short distances, but at intermediate distances the attraction increases. Continued increases in distance results in less interaction and eventually leads to a tendency of repulsion.

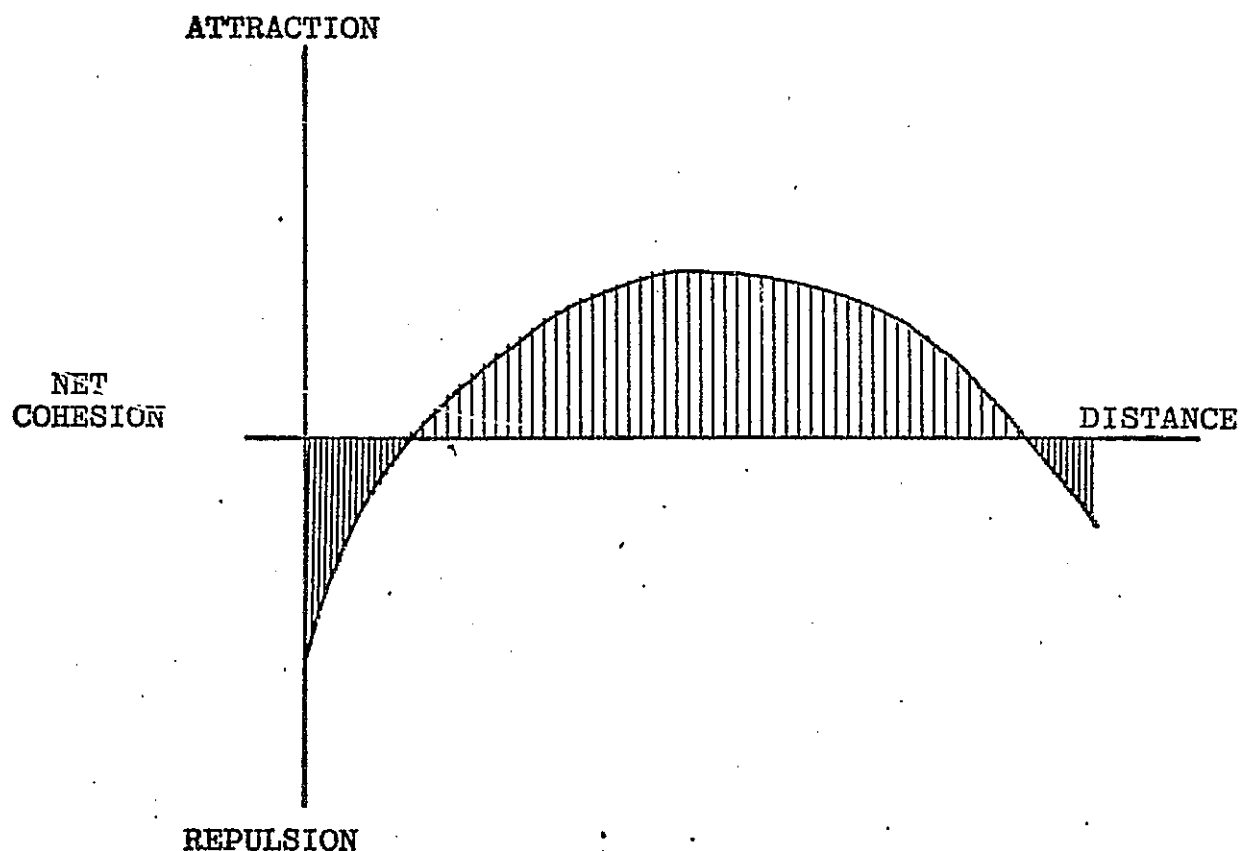


Figure 57. Net Cohesion and Distance

Modification of this diagram to include the implications associated with the individual levels of specialization and their effects on perception and interaction is incorporated in Figure 58. The inclusion of the interaction variable in Figure 57 results in a three dimensional representation of the complex relationship existing between individual interaction and space. By providing several leaves to the interaction surfaces individual behavior patterns may be observed. Persons who rank at higher levels of specialization are far less sensitive to the decaying function that distance has on interaction and human attraction. As observed in Figure 55, the behavior of all groups is very similar for short distances and it is not until the distance increases do we see a significant separation in the interaction surfaces.

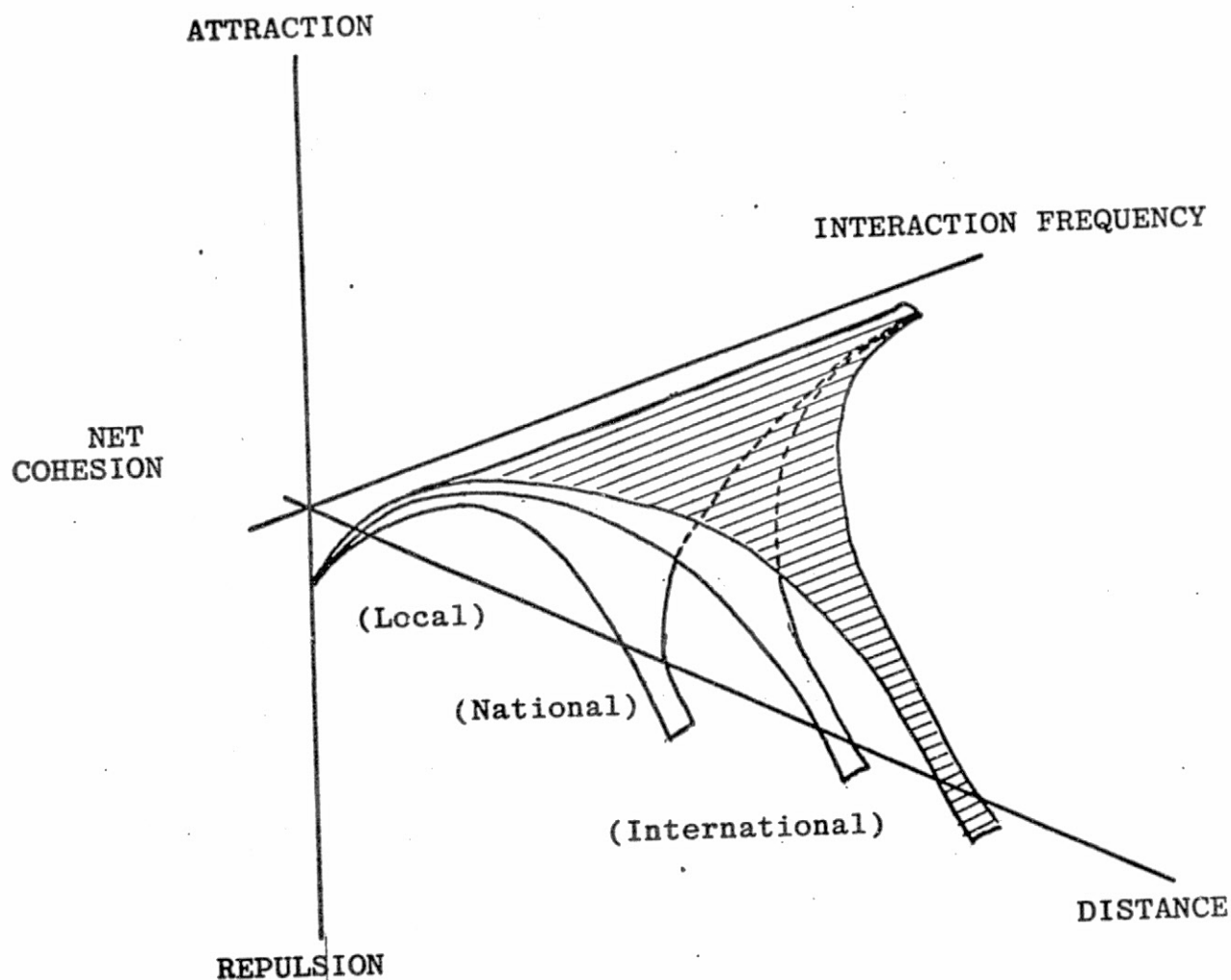


Figure 58. Multiple Interaction Frequencies and Net Levels of Cohesion

3. A SPATIAL INFORMATION MODEL

Construction of a model based on the notions just presented provides a basis for showing the applications of information theory in a spatial context. Observed variations in the informational field characterizing individual cities and regions is felt to be responsible for areal differentiation in how a place is perceived and the anticipated behavioral responses of phenotypic groups housed in that location. Emissions from the informational field of a city are the perceived function of the social and economic structures of the urban unit. The image

a city emits to a human receiver is a function of the quality and quantity of the information which flows through the urban system. Provincially perceived cities are likely to be characterized by a locally oriented information field which lacks high absorption levels to external data flows. Isolation of the information field creates a local and generally non-diversified image. A highly localized information environment may create serious barriers to the dissemination of external information flows. An example of this is found in the work of Sims and Baumann [217] who found a higher death rate associated with tornadoes in the southeastern portion of the United States as compared to the Midwest. The dissemination of tornado warnings and the behavioral response to it have been demonstrated to have greater cultural resistance in the southeast. This resistance may be in part the result of a more local and less diversified information field that has not fostered external linkages.

A model that defines both the quantity and quality of the information field for a region provides an effective diagnostic tool for evaluating the perception and response patterns for externally generated information. Variations in the rates of growth between regions may be partially explained by the nature of the information field. Areas which are characterized by large amounts of spatial interaction which well may be a function of the phenotypic mix, are generally more integrated into world wide information flows. Innovations are fostered and more easily accepted in the conducive environments characterizing such regions. The significance of information oriented centers as leaders in the innovation process may provide a rationale for a hierarchical diffusion process into the more provincial hinterlands.

The first dimension of the proposed model deals with the distribution and amount of information available in a specific location. Although quantity is recognized to be a gross measurement of information, it does provide an initial basis for analysis of the observed variations. Meier has observed significant differentials in the quantity of information between the developed and underdeveloped world. Meier [204] cites an estimated differential in per capita information units between the United States and Indonesia as being respectively 100,000,000 to 1,000,000 non-redundant information units per capita per year. A hypothetical cross-section through the United States illustrating the variations in the quantity of information would probably highlight the U. S. Manufacturing Belt. Major cities such as New York, Chicago, and Los Angeles would become peaks on the information surface.

Size of the population cluster alone would not necessarily be synonymous with the amount of information. Phenotypic variations by cities or regions would result in different mixes of information both being generated and demanded. Similar size cities may vary significantly in available information as well as in its quality.

The criteria used to determine the first dimension of the model may be based on gross data which depicts the quantity of existing information. Library circulation, newspapers, radio and television stations,

telephones, magazine circulation, population density when aggregated on a per capita basis would provide a crude measure of the quantity and intensity of information available in a specific location.

The quality of the information field is the second and most important dimension necessary for a realistic and operative model. Economic, political, and social structure, if dissected, provides the necessary parameters for defining the quality and orientation of the information field. Increased specialization of a population through education and economic attainment contributes to greater spatial interaction. Hence, the phenotypic mix characterizing a region is instrumental in defining the quality of the information flow within and through the region.

The quality of the information field is an aggregation of the share and orientation of individual phenotype's internal and external information flows. If the society is characterized by a large number of individuals whose orientation is toward a more local emphasis, we would find a filtering effect on information generated from external sources. In a recent study by Zelinsky [218], the following hypothesis was tested for the United States.

"That the increasingly free exercise of individual preferences as to values, pleasures, self-improvement, social and physical habitat, and general life-style in an individualistic, affluent national community may have begun to alter the spatial attributes of society and culture in the United States to a significant extent."

The hypothesis seeks to determine whether regional differentials in the cultural character of the U. S. exist. In other words, Zelinsky is concerned that the erosion of conventional social ties and the increased spatial mobility of our population is establishing a social entropy over space. It is anticipated that over time individual regional variability is being eliminated. To test this notion a factorial model is used employing unobtrusive measures related to specialized subscription patterns and to voluntary membership roles in special interest organizations. While, Zelinsky is unable to prove or disprove the hypothesis in his study, substantial regional differences appear to exist at this time.

It may be anticipated that the degree of variation on such dimensions within a relatively homogeneous nation, such as the United States, would reveal even greater areal differentiation in less developed nations. The spatial differentials in these regions may indicate similar variations in acceptance and possible resistance to technological innovation. The values and norms which characterize the phenotypic mix of these regions will determine their perception and possible reactions to a new innovation. The relatively complex regional patterns defined by Zelinsky are included in Appendix K of this paper.

The quality of information dimension must be derived from a disaggregation of the quantity aggregate discussed earlier. Content analysis

of newspapers, radio, television, library circulation, voluntary organization membership, occupation and social dimensions would all be determinates of the orientation of information penetrating the society and flowing through it. Critical analysis of the urban time budget would provide additional measures of the disaggregated information field. Meier, for example, suggests that the urban time budget would represent an indicator of the degree of diversification characterizing a society. He suggests that one may derive from the slope of an aggregated community time budget an index of the level of urbanism characterizing the location. Hence, content analysis of human time allocations to various sources of internal and external information flows are critical components of the quality dimension.

Obtaining relative values based on a region's position on the quantity and quality information dimensions provides a two dimensional structure for the analysis of information fields. Figure 59 illustrates the two dimensional structure with the X axis reflecting a continuum of the quantity dimension and the Y axis acting as a continuum for the quality information dimension. It is suggested that the

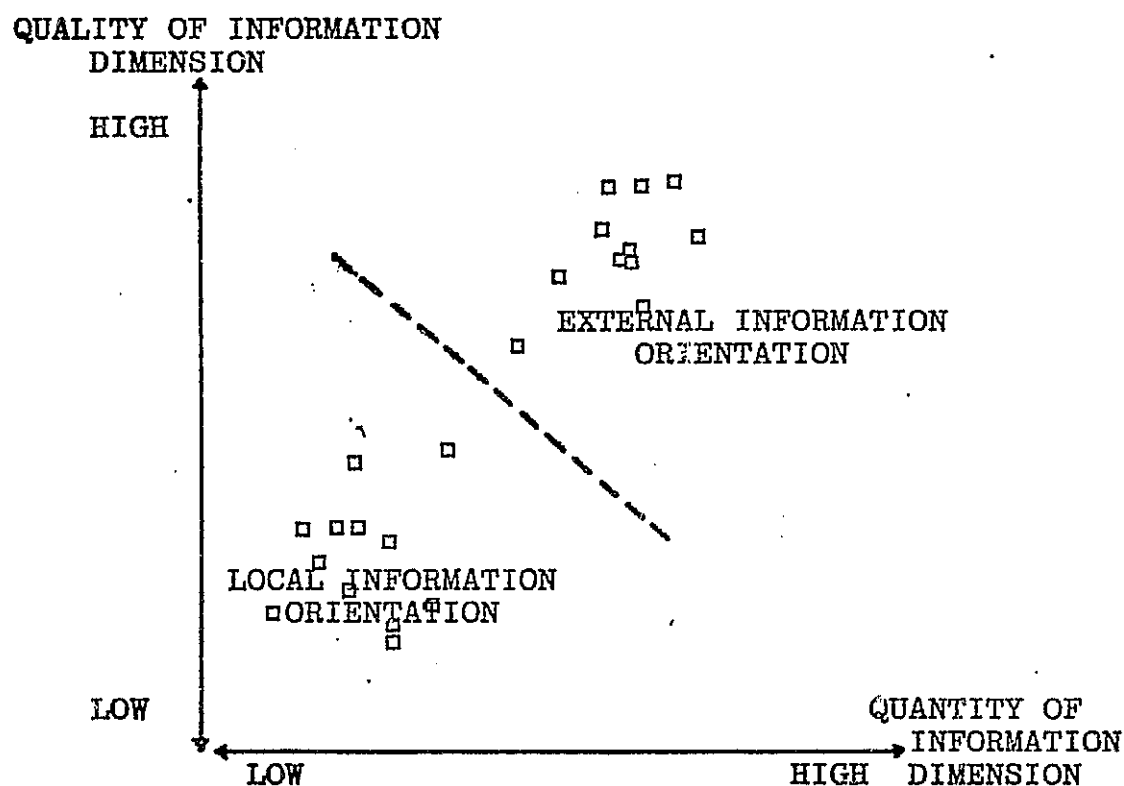


Figure 59. Community Information Orientation

relationship between quality and quantity is generally positive, thus, a place which ranks high on the amount of information would probably also rank high on the quality dimension. Assuming the alignment of individual observations on the above scatter diagram are valid, it is suggested that a realistic evaluation of the localized versus the cosmopolitan regional character of an area could be defined. A high rank on both dimensions would be indicative of a very high quality of information, as well as, a large quantity. External information flows would be perceived readily and based on the value implications would be accepted or rejected. It is anticipated that regions having low positions on both dimensions would have substantial barriers to the inclusion and perception of external information linkages.

Allan Pred [209] suggests that the flow of information through an urban spatial system will reveal a correlation between the degree of interurban interdependencies and the specialized information flow. This relationship will then stimulate the development of new interdependencies. Pred indicates that the following relationships may be exhibited in the interregional information flows:

1. Biased spatial specialized information flows will be similar to the interurban flows of goods and services.
2. General spatial stability will exist in the patterns of information flow.
3. The larger metropolitan areas will have greater accessibility to non-local specialized information flows.

The above relationships are generally consistent with the preceding multi-dimensional information model proposed in this paper.

The changing economic structure of a region through time illustrates the need to incorporate a temporal dimension to the information model. Figure 60 demonstrates the effect that the inclusion of time would have on the two dimensional model. The three dimensional character of the relationships in the preceding diagram permits the observation of the continuum noted in Figure 59 as a series of shells in which their proportional share of the total system diminishes or increases over time. The local information shell in the above case is seen to be shrinking as a result of technological innovation which is permitting higher levels of spatial interaction. It may be noted that the entire system is expanding over time because of the expanding information field.

A more realistic combination of the elements of time, quantity and quality of information, and geographic interaction and intensity is illustrated in Figure 61. In this figure the high points on the interaction surface (Locations X and Y characterize urban centers with the low relief

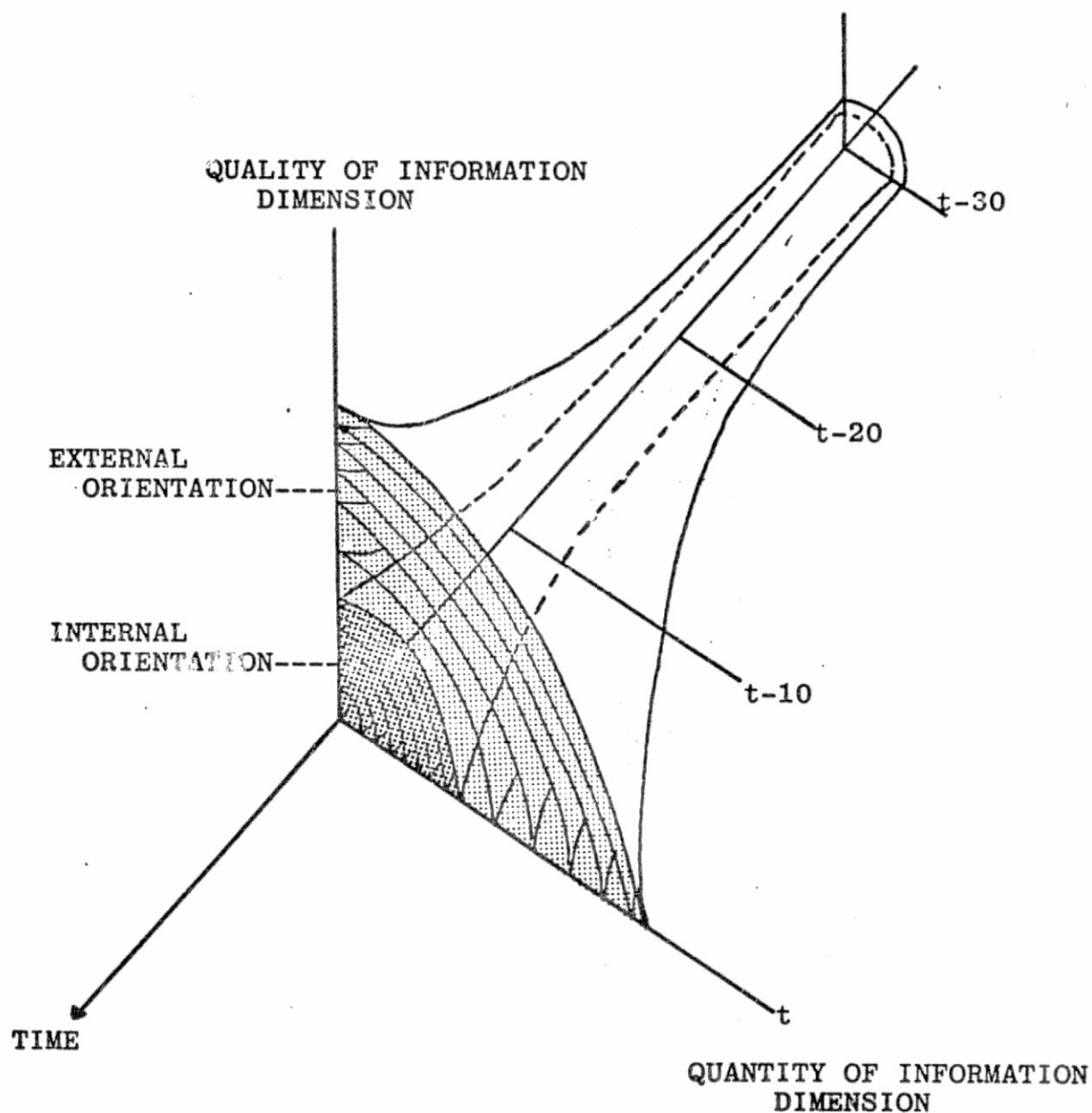


Figure 61. Temporal Implications of the Information Model

areas representing peripheral locations (Locations W, A, and B). Disaggregation based on Webber's notion of specialization and geographic interaction results in a partitioned information field based on interaction at local, national, and international levels. The inclusion of

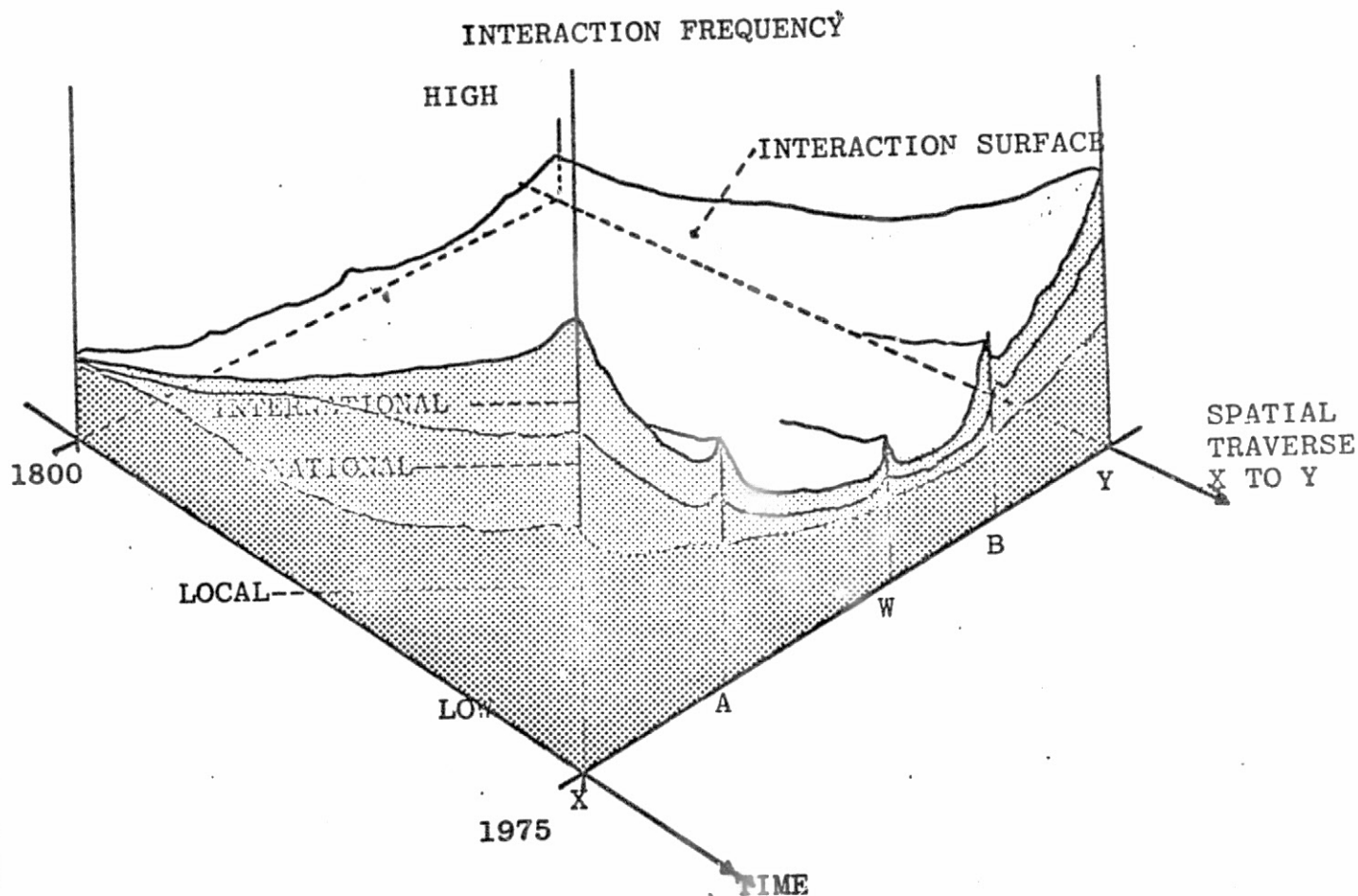


Figure 61. Communication Interaction Surface Over Time and Space

time demonstrates structural changes in the urban information flow resulting from technological advances. As one moves back through time it is hypothesized that in general the informational flow becomes more locally oriented, as well as, experiencing a reduction in quantity. The implications of the preceding to the acceptance and resistance of technological innovation depends on the following conditions.

4. THE PHENOTYPIC STRUCTURE OF THE SOCIETY

The above assumption is based on a behavioral concept and according to the model defines the population character of the society by means of its phenotypic mix. The preceding sections have illustrated that spatial

sensitivity and receptivity will vary by socio-economic class. It is the assumption of this paper that the above will generate differential adoption rates for new technology and for the transfer or diffusion of technology by phenotypic group. This assumption relates, in part, to the personality traits and potential actions of phenotypic groups. The literature in diffusion theory is still at an early stage with respect to this notion. However, the literature on hazard perception [219,217,220] suggests that such differentials may be anticipated. Baker and Patton [221], for example, found that educational and income levels appeared to be important in defining differential attitudes toward hurricane hazards on the Gulf Coast.

"It would thus seem that efforts to remedy false beliefs and conceptions which result in negative attitudes toward damage prevention measures might consider the individuals education level and his site above other variables. Better educated respondents are more likely to have a positive attitude toward damage prevention adjustments" [221].

Based on these conclusions, Baker and Patton suggest the following efforts be undertaken:

- "1. Low-education groups should be given priority as targets of information.
2. Pamphlets or messages disseminated might well contain somewhat differently worded information depending on the general education level of the target audience."

These statements are consistent with the information model which suggests that a location information field will reflect the aggregate information fields of the phenotypic groups which comprise it. According to Baker and Patton [221] an absence or limited number of elite phenotypic groups may generate an information field which is very local in orientation and generally parochial in attitude. Such a society, would be more likely to resent new innovations and be generally less receptive.

5. THE SCALE OF THE DIFFUSION PROCESS

The preceding model has generally been employed at a macro-spatial level (national or international). This is consistent with the contemporary "growth pole" literature and its relationship to spatial diffusion theory. The initial concept of a growth pole was developed by Perroux [222] and represented a polarization in the economic structure of an economy. The concept was then modified to include a geographic component by Boudeville. A geographic growth pole represents an areal concentration of economic activities in space. The dynamics of the growth pole concept as a spatial generator for the diffusion of cultural change and technological innovation is more apparent in the early work of Myrdal [223] and Hirschman [224]. Friedmann's [225] classic study of the Venezuelan space

economy illustrates an operational aspect of the growth pole or core-peripheral model. In this study he demonstrates that the differential growth rates of core regions (growth pole areas) compared to the peripheral regions causes the development process to move through a series of unbalanced disequilibriums. A relatively recent application of this was demonstrated in the development of Threshold Analysis. This methodology as reported by Kozlowski and Hughes [226], was designed by Polish planners to define the major investment steps in long term regional planning. The fundamental assumption of threshold analysis is based on the notion that steps or points of discontinuity occur in urban development processes. An important implication of this is that regional growth is not continuous, but is marked by a series of successive limitations (thresholds) which must be overcome.

The spatial implications of regional growth dynamics to the growth pole concept represents an important contemporary research frontier. Recently, Brian Berry [227] has argued that the growth centers (poles) function in regional development theory as a special case of the general innovation diffusion process. The apparent coalescence of growth pole and diffusion theory may provide the theoretical infrastructure for the key spatial components of technological acceptance or rejection over space.

An exploratory paper presenting the preceding theme was recently presented by Lawrence Brown [228] at the International Geographical Union Pre-Congress Meetings. In this paper, Brown defines three major areas for consideration: macro-scale diffusion models, meso-scale diffusion models, and the relationship between the diffusion of innovation and the dynamics of growth poles in regional development. This paper is an important step in the literature for it provides additional insight and expands the traditional macro diffusion model of Hagerstrand [229]. In the traditional model, Hagerstrand identifies a hierarchy of networks for social communication through which an innovation is filtered. In a single location this diffusion process may flow through a local social communication network [230]. Extending the geographic scope involves coordination of the diffusion process with an interregional network that reflects a traditional central place hierarchy. The central place hierarchy would define the system of cities in a region and the hierarchical elements of their interactions.

These concepts are consistent with the earlier stated information networks and the differential connectivity of those systems. This relates to the aggregate influence that phenotypic groups residing in a location would impart to the diffusion process. In Figure 61 growth poles were defined at locations X and Y. A macro-scale diffusion would demonstrate an initial flow between these two poles. This would be the result of a greater propensity to tap national and international information linkages. In Figure 62 a hierarchical diffusion network is illustrated for the locations along the traverse from X to Y (see also Figure 61). According to the traditional diffusion model the flow would be initiated from location X to a smaller growth center at Y. The item being diffused then would flow to location W, a smaller secondary center. The second level of the diffusion hierarchy would be more dependent on a stronger local orientation in the information network.

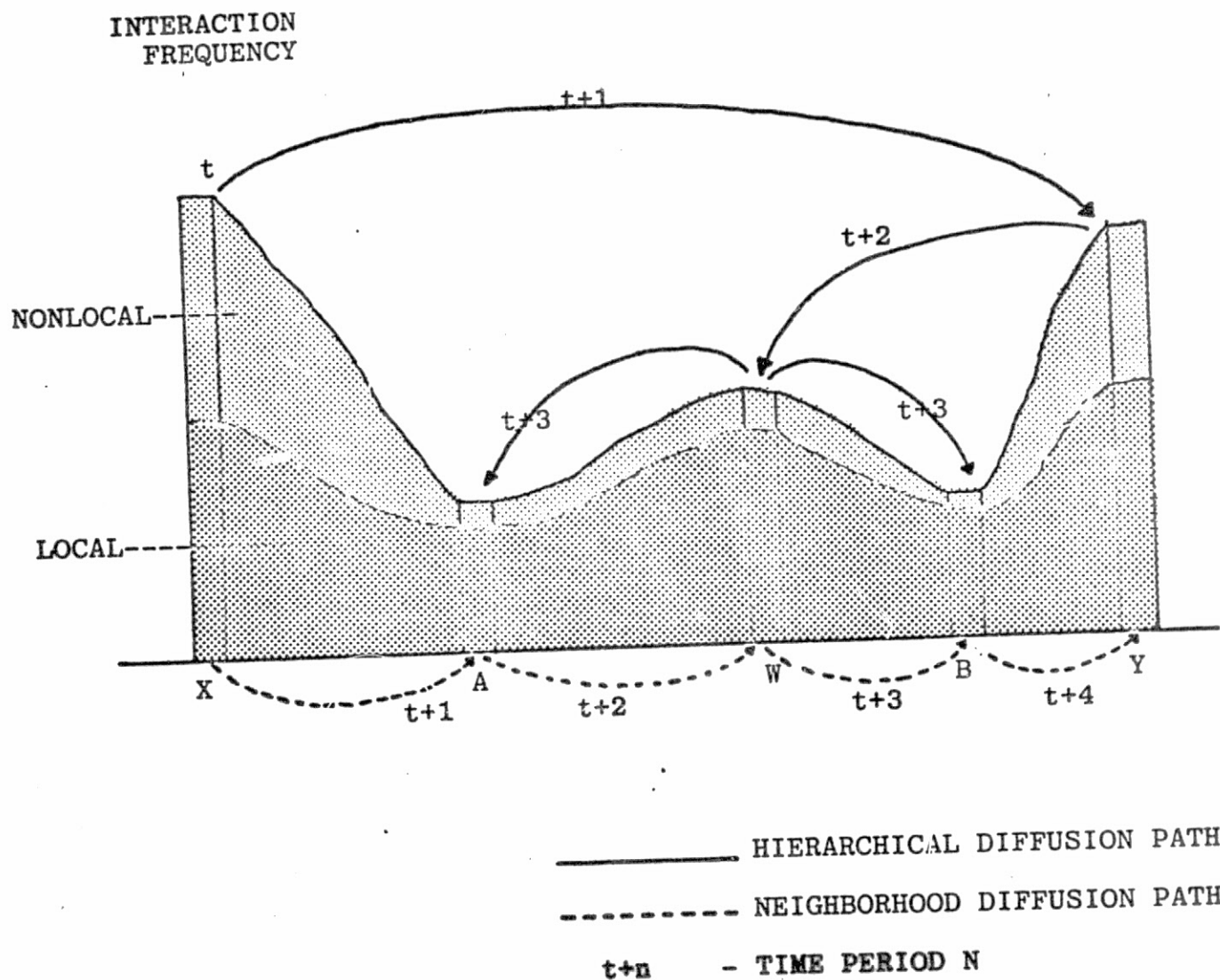


Figure 62. Hierarchical and Neighborhood Diffusions on a Spatial Traverse X-Y

The above diffusion system relates to a macro level diffusion process and is dependent on the aggregate information fields of the related locations. Brown, however, suggests that the above diffusion system may only be operative for specific items being diffused and for specific agencies of diffusion. The above diffusion process, according to Brown

[228], will most likely be followed where higher levels of capitalization are available and the propagator is a monopolist or oligopolist. Where high-risks and uncertainty exists with low capitalization the diffusion would normally follow a neighborhood or local diffusion process (Figure 63).

	UTILIZATION OF EXISTING NETWORKS OF DIFFUSION AGENCIES	ESTABLISH OWN NETWORKS OF DIFFUSION AGENCIES
LOW CAPITALIZATION	NEIGHBORHOOD EFFECT BUT WITHIN CONSTRAINT OF EXISTING NETWORK	NEIGHBORHOOD EFFECT
HIGH CAPITALIZATION	NO NEIGHBORHOOD EFFECT BUT CONSTRAINT BY EXISTING NETWORK	NO NEIGHBORHOOD EFFECT

Figure 63. Brown's Typology of Diffusion Processes

In respect to a cost-benefit analysis of an early warning technology, we may anticipate the diffusion process to be most adequately represented by the conditions in the lower right quadrant of Figure 63. The above diffusion would be undertaken by the government and would represent high capitalization within its own diffusion network. Brown notes that under perfect competition to potential propagator would not be able to establish his own network and that available capital would be more limited. He concludes:

"the location of an adoption agency in the pure competition case will be dependent upon site factors related to profitability, opportunity costs of agency adoption, and the human resources capable of being aware of and exploiting the innovation. However, situation factors related to learning about the innovation agency also are important.....Thus, Hagerstrand's theory that a regional network of communication is critical and appears relevant for the pure competition case of diffusion in the macro-scale, although the network probably involves several types of communication, not just

interpersonal. While the characteristics of such networks are not known, both the above reasoning and the empirical examples of Tanaka and Shawyer point to the frequent occurrence of a neighborhood effect pattern of diffusion" [228].

Figure 62 also suggests that the lower levels of the hierarchical diffusion network become more dependent on local information fields. Diffusion processes at the meso-scale (a single center and its rural hinterlands) or at the micro-scale (diffusion within a single center) are characterized by different mechanisms. At these scales the aggregate share of various phenotypes residing in a location remains relevant, but also the actual locations of the phenotypes within the region may become critical factors in the diffusion system.

To understand the diffusion process at this scale the social ecology of the center and its environs becomes an essential consideration. It may be anticipated that urban and suburban populations reveal higher degrees of articulation to total information flows and would be generally more sensitive to innovations than the populations that are located peripheral to the center. This would probably be most apparent in the developing world where more abrupt cultural differentials are exhibited between urban and rural populations. On the other hand, however, the more developed urban societies will demonstrate greater variety and more subtle forms of social differentiation in space.

The social area school and the factorial ecology models represent spatial-sociological dimensions of social differentiation. Both approaches as discussed by Shevky and Bell [231] and Murdie [232] define urban structure by means of three major dimensions: socio-economic status, family status (life cycle), and ethnicity. As Lampard [233] notes differentiation of an urban society views urban growth as a function of "the concentration of differentiated but functionally-integrated specialisms in rationale locales", thus "specialization of functions makes inevitably for specializations of areas Areal differentiation is, in fact, the spatial corollary of functional specialization and logically serves the same end". Hence, the above models are structured on the foundation of a theory of social change. As economic development proceeds the increased specialization and emergence of complex roles results in greater social differentiation. This increased social differentiation is reflected in greater areal differentiation among the previously noted dimensions.

The socio-economic status dimension, for example, represents the degree of social stratification and would be derived from the social inequities of class, status, and power. The family status or life cycle dimension reflects differentiation in age and marital status. The preceding becomes more relevant as a society experiences a shift from an extended family pattern to one based on the nuclear family concept. Several transitions are associated with the life cycle dimension: a pre-child bearing stage, child bearing stage, child rearing stage, child launching stage, post child stage, and widowhood. Each of the above stages represent changes in ones position in a society. The combination of the socioeconomic status and life cycle dimensions provides the basis for the concept of social space (Figure 64).

One's position in social space may be defined by reference to the axes in Figure 64. The taxonomic distance between groups in the figure represent their social distances. For example, groups B and D would represent relatively similar groups. Both are located in the child bearing phase of the life cycle dimension and both exhibit a relatively low position on the social status factor. The distance between groups B and F, on the other hand, would represent groups that are significantly different. The factorial ecological models have utilized census tract data and have found that census tracts will exhibit patterns very similar to those found in Figure 64.

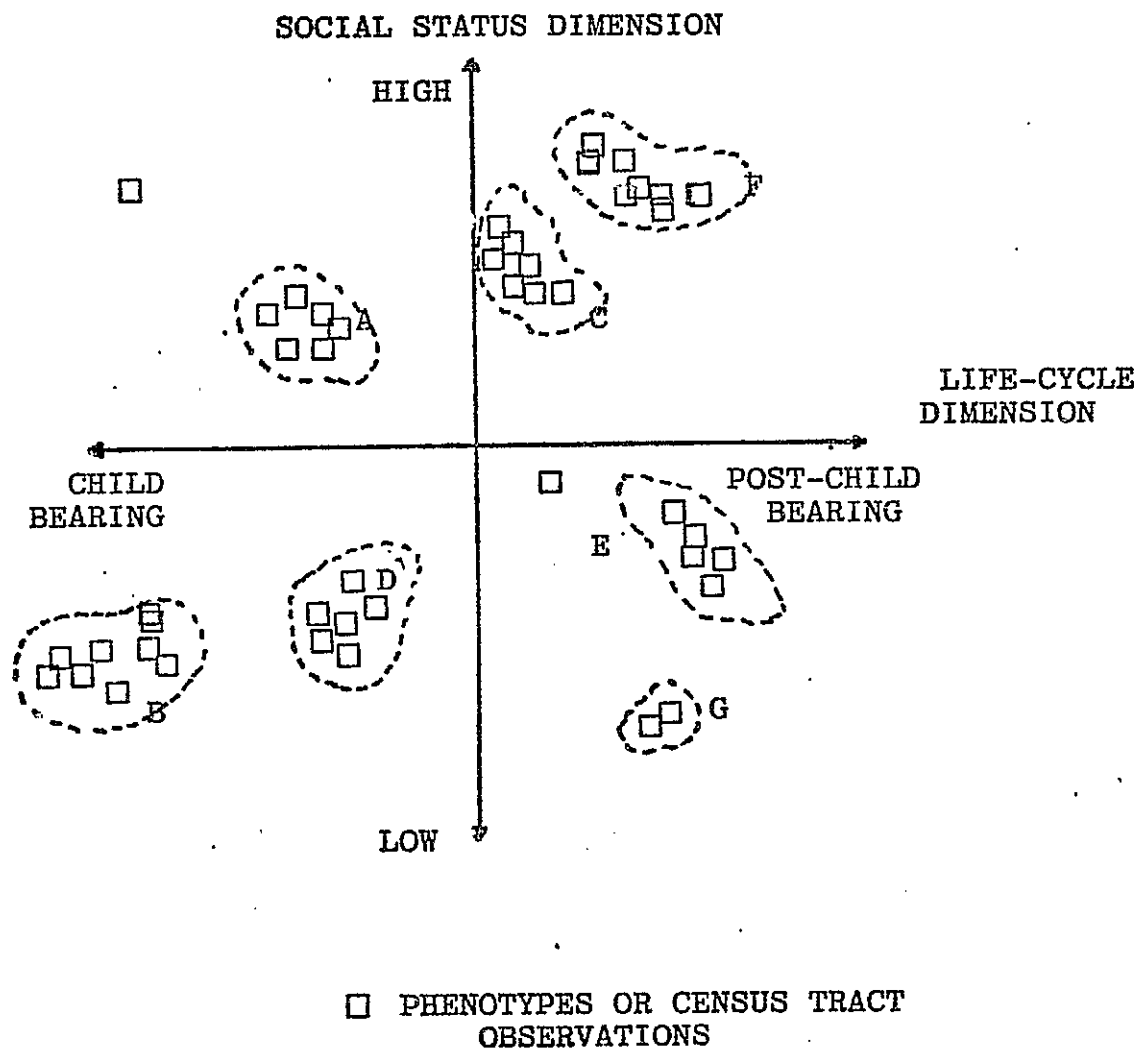


Figure 64. The Concept of Social Space

These findings suggest that ecological data could be utilized in defining phenotypes and their locations in social space. Behavioral and attitudinal patterns may also exhibit a similar orientation in

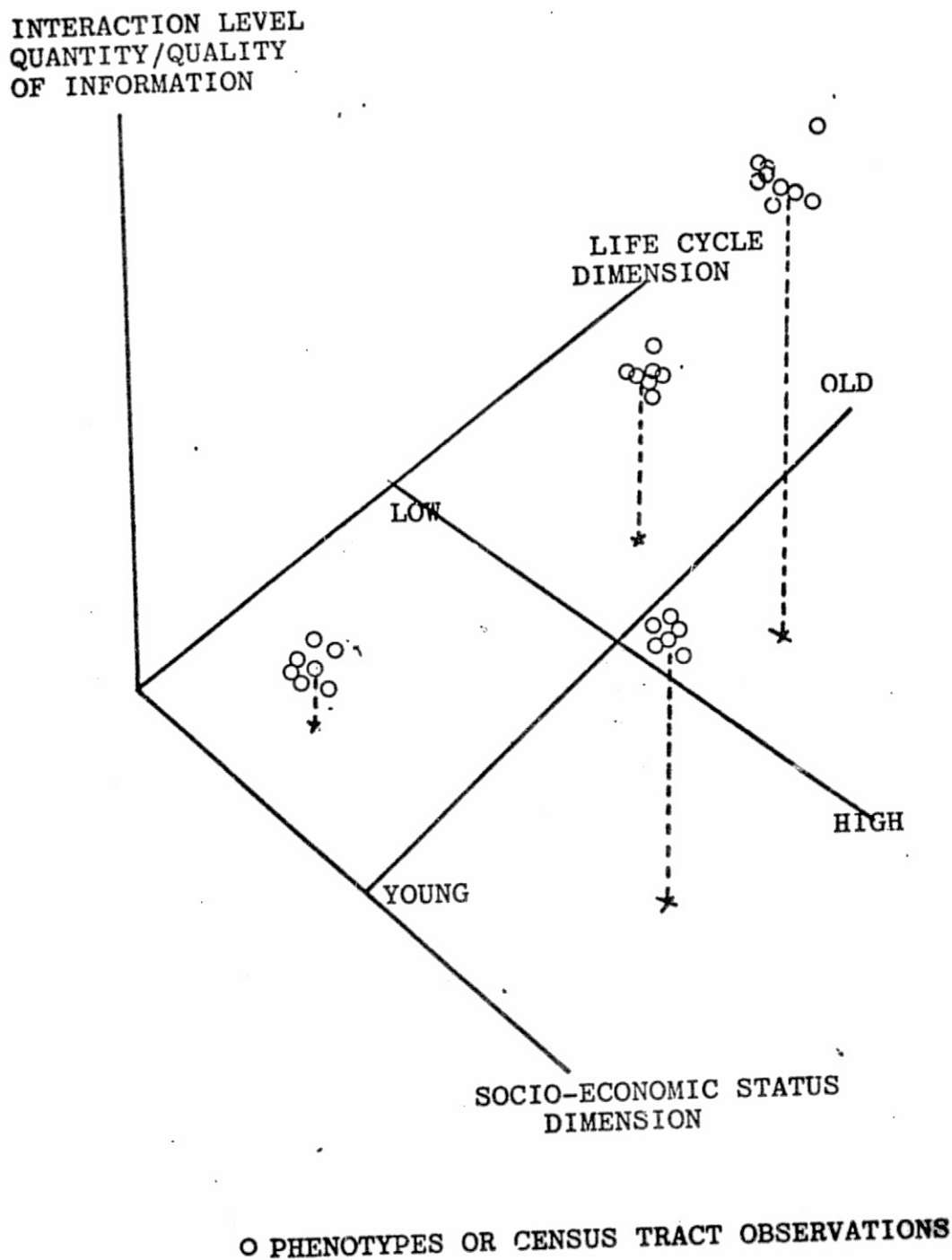


Figure 65. Information Interaction Levels and Social Space

social space. In Figure 65 the information dimension is included within the social space dimensions. The clustering of individual groups in the various quadrants would represent different phenotypes in relation to information quality and quantity. It may be anticipated, based on the previous sections of the paper, that the higher social status and late child rearing groups would demonstrate the greatest accessibility to information flows. On the other hand, low status prechild groups would have the most limited accessibility to information. In general, the preceding is demonstrated in the literature of geographic perception. Children, for example, have been shown to have only limited exposure to nonlocal information sources and flows. Their world, in essence, is their neighborhood or block. Their exposure to outside sources of information is generally very limited and not directly obtained from their activity space. The preceding may be further intensified by the development of social or physical barriers. Thus, a child living in a ghetto, is even further detached from the main stream of the societal information flow. The information that reaches such a child comes from his indirect contact space and may be diluted through a set of cultural filters. His behavioral environment may be radically different from that of a child who has accessibility to a broader and less spatially concentrated information field.

This suggests that the socioeconomic and life cycle dimensions may be utilized to define basic phenotypic groups and their associated information fields. It also suggests that spatial regularity in their locations may be defined. A recent study by Berry and Rees [234] utilizes the notion of social space in association with a concept they call housing space. It is their conclusion that the dwelling unit stock of a city is equated with ones position in social space. In Figure 66 the housing space concept is used to predict the location of phenotypes in a community. The diagram shows that based on the social space dimension differentiation will occur in the types of housing and ultimately in the location of the residence. This differentiation will exhibit predictable patterns over space.

Spatial regularity in the social space dimensions has been verified in the factorial ecology literature. Anderson and Egeland [340], for example, utilizing an analysis of variance model found that the socioeconomic status dimension indicates a generally sectoral orientation in the urban region. The life cycle dimension, on the other hand, generally exhibits a concentric zonal arrangement. Subsequent research Johnston [235] and Clark and Gleave [236], have verified Anderson and Egeland's findings for other cities in both Europe and North America. Figure 67 indicates how a hypothetical urban region may be defined using the sectoral and concentric zone configurations to generate a composite neighborhood taxonomy.

This suggests a relatively complex social gradient in the city. It may be anticipated from Figure 65 that the information field over the city will reveal a similar gradient by neighborhoods. This gradient would represent various phenotypic groups and their perceptions to information flows

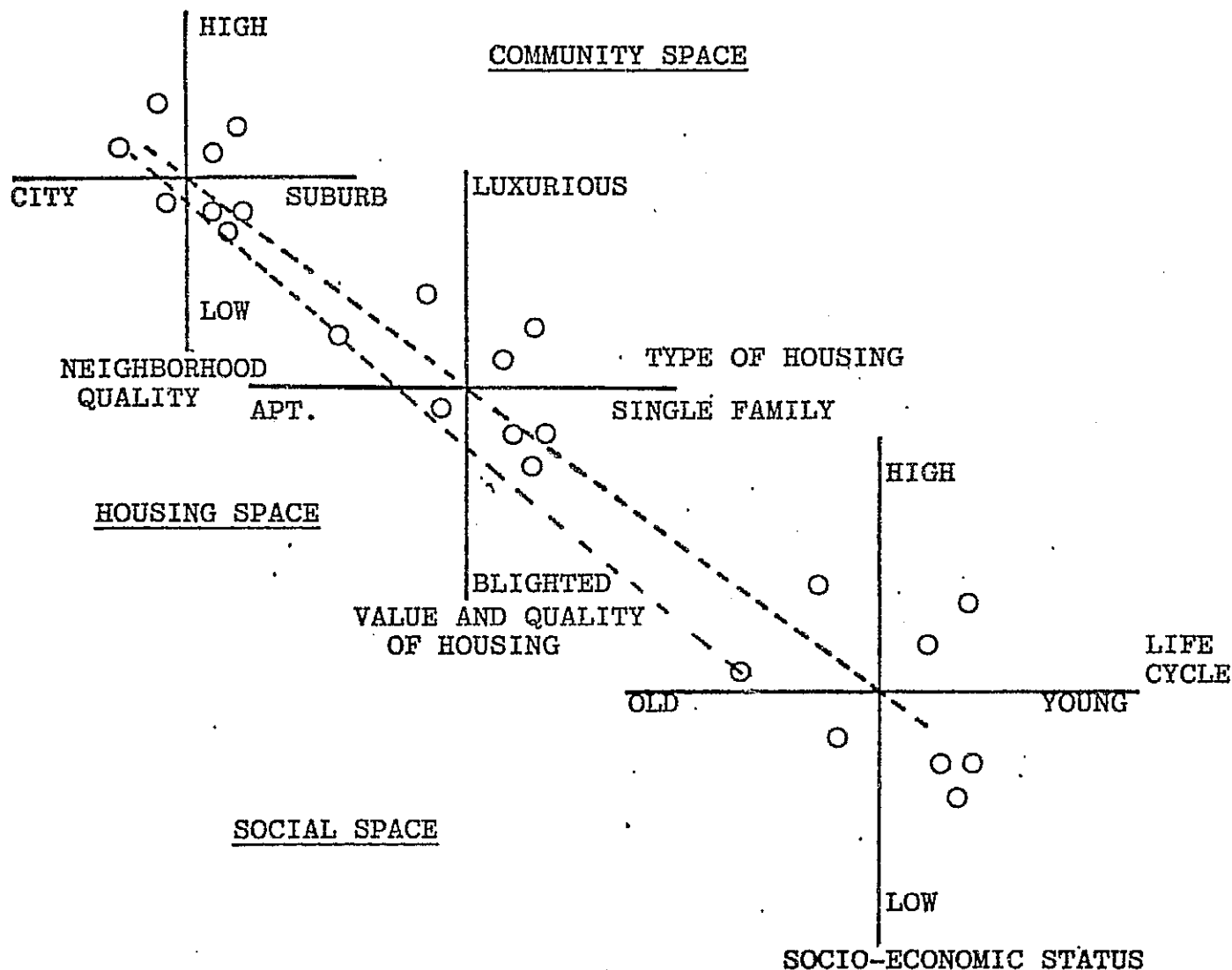


Figure 66. Social Space, Housing Space and Community Space

of a local and nonlocal nature. The preceding would define the impact areas where new innovations would have a potential rapid or slow adoption rate. The success or failure of the innovation may be dependent on who accepts it and to what use it may be applied. Areas in the city comprised of phenotypes having a strong provincial perspective may demonstrate resistance to innovations that come from outside the local information network.

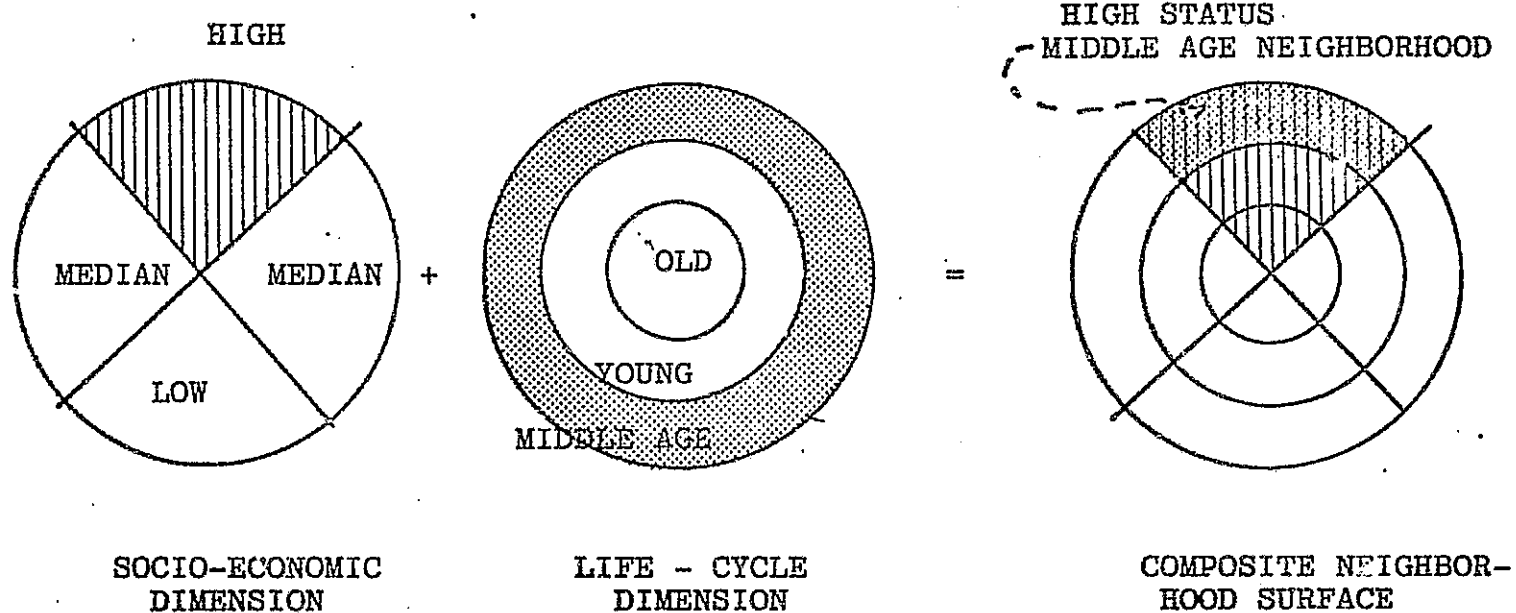


Figure 67. Spatial Differentiation of the Social Space Dimensions

While this theory is speculative in relation to attitudes toward technological change, there is, as noted, good reason to expect that the theory will hold consistently. A problem encountered at an aggregate ecological level of analysis is, as noted by Alker [237], associated with the ecological fallacy of attempting to predict individual behavior from group data. This necessitates bolstering the ecological analysis by survey research techniques.

XII. PHENOTYPIC EVALUATIONS IN THE ACCEPTANCE OR REJECTION OF INNOVATION

1. INTRODUCTION

If the model we are proposing is to afford additional insight into the potential benefits or costs of a technological innovation it will have to be assessed in terms of meaningful social groupings. In our process we are speaking, of course, of the social psychological phenotypes. We are also speaking of the process of change and adaptation and of integrating people into the social system. It is felt we have stressed the concept of the phenotype sufficiently to this point. However, we have only addressed the potential for the phenotypic groupings playing an advocate, neutral, or adversary role in terms of marketing. Additionally, we have only considered change in terms of social systems change. Therefore, we are going to discuss the notion of change in a slightly different fashion with an eye to showing that the impact of change or potential for change is partly responsible for the subsequent perception of an innovation and choice of adaptation. Along the way we intend to show how membership in a particular phenotypic grouping is related to the adaptation options available and the potential dysfunctional adaptations that could result from a blockage to participation.

2. CHANGE

Structure in general and organizations in particular have emerged as important elements in dealing with the major process operating in reality, that is, change. There is in fact nothing permanent in reality but the process of change itself. Yet understanding change is largely dependent on one's point of view. There is obviously some permanence or else identification itself would be impossible. For example, one is the same person as 10 years ago and yet, vast cellular changes are known to have taken place. Italy is still the same country as 2,000 years ago and yet it is greatly changed.

In the study of change at the social system level, scientists have tended to focus on the patterns of change. What is the structure of a society and the elements of the cultures of the society? What is the composition, content and relationship of the role structure of the society? In other words, what is the pattern of the society? Additionally, one might ask what is the process of change itself and its relation to structure. Most social scientists agree that the discussion of social change must deal with structural changes, since on going process is really a steady state within all systems and therefore not change.

In the study of change early scientists focused on such change processes as evolution, development, emergence, and progress. Again, their point of view becomes the important factor in ascertaining what these scientists were attempting to show. The concept of evolution was given great impetus by the works of Darwin in dealing with biological evolution. It also influenced the development of social thought including that of two prominent early sociologists Comte and Spencer. The notion of social evolution led to the eventual comparison of society with a biological

organism. Historical and philosophical documentation was introduced to firm up the organic analogy. Yet there were dissenters. Scientists like W. F. Ogburn noted that the laws of heredity, variation and selectivity have no real counterpart in social and institutional change and development. While it is true that man has a social heritage (social heredity), it is not transmitted as in a genetic package, but rather in the traditions man learns between the womb and tomb. Changes in culture, institutions, societies, and traditions can be initiated, controlled, or delayed by the actions of man. That is, man is capable of deliberate action, conscious choice. Technology offered a perfect example of this deliberate and conscious choice. It also had a definite effect upon society in terms of change and adaptation. W. F. Ogburn addressed this effect in his theory of cultural lag. He noted that technology is capable of growing far faster than man's ability to adapt to the technology. In this view, Ogburn paid special attention to the role of invention.

Modern social scientists are also concerned with this phenomenon studying the social demographic movements in societies, changes in the socialization process and structures of the family, the socioeconomic composition of the class structure and religion.

Historically, one should also be familiar with the works of Marx and his application of the dialectic to the study of the past and projections of future social development. Many other scientists along with Marx noted the cyclical features of change in societies. Of these scientists perhaps none more explicit concerning this cyclical aspect than Pareto [175]. Additionally, Toynbee [238] and Sorokin [239] discuss the cyclical nature of civilizations as including the processes of growth, arrest, and decay. Both these scientists also stress the developmental linear progression found in societies. Toynbee discusses this facet in terms of the simultaneous linear progression of civilizations which while remaining separate entities also represent a single species engaged in an identical enterprise. He notes, the "differentiating Yang-movement of growth is leading towards a goal which is a Yin-state of integration" [238].

In the present view, the concern is with changes that minimally affect social groups, and ultimately bring about changes in the social system. This view of systems is concerned with open systems capable of correcting deviations (negative feedback) and subject to deviation amplifying feedback (positive feedback). In other words, we are concerned with a new relationship between the component parts of the system and with the component sub elements of the system, namely institutions. It is this alteration in structure that we call change. Gerth and Mills [170] have constructed a model of social change helpful in grasping the complexity of the process which is subsumed in the following six questions:

1. What is it that changes?
2. How does it change?
3. What is the direction of the change?
4. What is the rate of change?
5. Why did change occur or why was it possible?
6. What are the principal factors in social change?

Each of these questions represent a different facet of change some of which are more amenable to understanding than others. The first two of these questions are usually answered that it is the structure which changes in relation to alterations in the functions associated with it. The direction of change (question 3) is much more difficult to assess in that it is difficult to determine whether the structure is emerging or decaying. It depends to a great deal on one's viewpoint. The rate of change (question 4) is also difficult to assess since it is often both subtle and slow. In open systems in which negative and positive feedback forces operate it becomes additionally complex as the forces tend to cancel one another. In providing insights as to why change occurs social scientists have proposed a variety of factors including the following compilation presented by Ginsberg: the conscious desires and decisions of individuals; individual acts influenced by changing conditions; structural changes and structural strains; external influences; outstanding influences; outstanding individuals or groups of individuals; a confluence or collocation of elements from different sources converging at a given point; fortuitous occurrences; and, the emergence of a common purpose. Obviously, some have a greater potential than others for introducing change. For the most part, the study of change has taken two courses; studies focusing on social structure and those focusing on the adaptation of individuals to change. Both types occur in the context of the family, religion, law, economy etc. The major focus has been on the adaptations of people to change and the subsequent implications for motivation to participate in the social system.

In terms of our present objectives the view of social change is oriented primarily to that change occurring within the system. Additionally, we are excluding outstanding individuals, outstanding influences and fortuitous occurrences. Our concern is with the effect of new technologies on the system and subelements of the system. The question underlying our consideration of change is: What is the implication of the change introduced by technology in terms of man's ability to adapt? It should be noted that just as the phenotypes enjoy a different relationship to the goods and services of a society, they also enjoy a differential ability to adjust to change. This has been shown dramatically and sadly in the recent war situation in South Vietnam. Some phenotypes flew out of the dangers posed by the invading army, others drove, others walked, and still others were forced to stay.

This discussion of change leads one to believe that it is a rational process—programmed activity designed to achieve a goal. However, as we noted earlier in treating Pareto's view of the social system, most of man's activity is non-rational and he simply explains the activity in rational terms. Perhaps an example will be useful in making this somewhat more clear. Let us assume that a drug company creates a new product designed to sweeten foods and, after testing, finds that under some conditions the substance may be carcinogenic in rats. However, the substance is cheap and a handsome profit is possible, if the firm is capable of getting the product to the market. As such, a corporate decision is made to utilize action to get the product "approved" and on the market. Rational activity is used in accomplishing the goal —

marketing the product. However, when viewing the total act along with the possibility of its being carcinogenic, the act becomes highly irrational. Examination of all the "rational" activity leading to the decision to market reveals an elaborate set of derivations to use Pareto's terminology. That is, an elaborate set of verbal utterances, assertions, appeals to authority, and rationalizations which when given the overbearing force of "sentiments" (the non-logical, unpremeditated, self-acting or moral forces) the explanations turn out to be mostly pseudo-logical. Pareto's point is that hard-core sentiments are the major forces operating on the society and are responsible for determining the form of the society. We don't mean to imply that rational activity isn't involved. The question is what is included in the decision-making calculus. A limited view, ignoring the test findings and emphasizing the corporate goal of making a profit, allows the corporation to act. However, it is Pareto's view that this activity is non-logical.

In our example, knowledge of the system and access to the proper institutions, coupled with control of the resources, coalesce to permit the sale of the substance. The only possible "benefit" is the direct flow of profits into the company. The costs are potentially extremely high to the total population. The masses of the population are in fact exposed to potentially high hazard. The decision process allowing this to occur was "closed". It involves "micro-thinking" with "macro-consequences". We referred to the basis of this problem earlier as residing in an atomistic view of social reality. It is strongly felt that we must move from this atomistic or molecular viewpoint to a molar one. Hence, our emphasis on total assessment.

3. POLITICS

It may be expected that the introduction of change will lead to groups of people espousing and adopting the change, others forming no opinion with still others opposing the change. In an open society the problem becomes one of ascertaining the effect or consequences of implementing the change on all these groups. Societies further have the obligation of protecting the "rights" of all its citizenry and hence, must have a technique of assessing the relative impacts on the groups in the society. Otherwise vested interest groups, such as our hypothetical drug company, institute innovations oriented to their interests and fail to assess the effect on the population. Government serves this function of mediating between the potential interest groups operating in behalf of the total population. In other words, the essence of a political system is sharing territorial rights and providing for mutual services such as protection. Examination of the extended organization of a society reveals that governmental bodies deal with both internal functions, such as, social control and welfare, and external functions, viz., relations with other groups and societies. In this sense, the political system is concerned with the authoritative allocation of values within a society. Since values are

part and parcel of all social life, the governmental function extends to a wide range of institutions including those concerned with goal attainment and policy formation, law, and adaptation or economics.

Michael Hurst [182] notes that since the early 1950's a number of social scientists have attempted to analyze political relationships in terms of a systems model. In Hurst's model the system includes, all systems models, inputs, conversions, and outputs. However, he points out that there are two classes of inputs, demands and supports. These inputs are generated internally by political elites and society as a whole and externally through relationships with other social systems. He notes the demand inputs include:

1. Demands for goods, such as food and clothing, for services, such as education, and for welfare measures, such as regulation of working conditions.
2. Demands for social control, such as safety in the streets and highways, or honest weights and measures in the market.
3. Demands to participate in the system by noting, or holding political office.
4. Demands for various kinds of symbolic output, such as the display of power during periods of crisis or external threat. [182]

Hurst presents a similar listing of support inputs which include:

1. Material factors, such as taxes, levies, or military service.
2. Obedience to sanctions, laws and regulations.
3. Participation, by voting, joining organizations, etc.
4. Deference to public authority in all its aspects, including the purely symbolic ones.

Depending on the size and development of the society these functional inputs will vary tremendously: Hence, the method of dealing with the inputs depends on varying social organization. For example, a hunting and gathering society differs greatly from a highly technological one and yet the functions are included and dealt with in both though the organizational structures become vastly more complex and differentiated in the technological society. Hurst demonstrates this complexity in a statement showing the relationship between politics and economics.

Laws, policies, and enactments, all of which directly affect the economic system, are formulated through the interest group mechanism, through formal policy proposals, through the conversion of policy proposals into authoritative rules, and through the transmission of information, both within the political system and from it to the societal milieu. In this way the inputs of the system are converted into its outputs. [182]

The next logical question becomes; what are the outputs of the political system? Hurst summarizes them as follows:

1. Extractions such as taxation.
2. Social Control, including control of economic behavior.
3. Methods of allocating goods and services (market structures, systems of collection and distribution, etc.).
4. Symbolic outputs, including the affirmation of societal values through ritual and ceremonial. [182]

Once such outputs are presented the members of the society respond either through supporting the policies or advocating new ones by the same means. While such feedback often produces conflict within the society it is really this two-way flow between the society and policy makers that constitutes part of the policy making process.

In the present view we are concerned with these political system processes as they concern the coercive authority within a territorial framework and as they affect relations among groups in the society. Groups such as labor, business, consumer organizations, ecological groups, and so forth.

In discussing the coercive authority of politics within a territory in relation to economics, Hurst discusses three possible relationships contained in the following questions:

1. Is government engaged in expansionist activity or does it rely on the intrinsic productive resources of the existing territory?
2. Is the political unit dominant over its own territory, or is it a satellite of some outside political or economic force?
3. Does the political unit allow economic activity to proceed in an autonomous way, or does it attempt to induce such activity?

With the emergence of multi-national corporations these questions take on ever increasing importance since those companies have no particular allegiance to any one country. The problem of control becomes an important consideration. Which laws apply? Are there laws governing these activities? Is it necessary to create a new body of international law governing and regulating such corporate activity? These questions well may be the most critical ones to be faced by nations in the next 20 to 30 years. They are important since companies operating in a "float capacity" within and on top of nations are, for the most part, unregulated by law.

At the group level political relations deal with those among organizations such as economic firms, as well as between such firms and other groups organized to protect their economic interests. This point is quite related at present with the problem of territorial regulation just discussed. The increasing size, complexity, economic and manipulative power can increase so as to edge out the smaller firms. Hurst [182] cites Neil Smelser in this regard who states:

As the size of the firm increases, its immediate capital problem recedes more into the background; if the firm controls a portion of the market, even demand ceases to be as active as a determinant in their behavior. At such a point their production and pricing policy comes to be more oriented to the behavior of other firms in the industry. Thus economic behavior comes to reflect more and more the political relations among firms.

It is precisely this phenomenon that has led to an increased concern within the United States to arrive at a more adequate benefit-cost assessment. The manipulative abilities of such corporations or firms extends well beyond the manipulation of materials and material resources. It extends to the very heart of the political process in the form of legal lobbying activity and, as recently shown, to the non-legal involvement in the political process through activities like illegal contributions to political campaigns. We point once again to the major behavioral axiom informing our endeavor, that is, men seek values through institutions utilizing resources. Specifically, we refer to the obverse of this statement discussed earlier, namely, those who control the resources exercise inordinate control over the value system because they control access to the institutions. In the present example, we are pointing to this affect in the political process. We might also note that the effect has been exploited by the marketing profession who by using their capital have gained access to the communications media in order to "sell" their products. In this case, there is a fine line between giving the people "what they want" and inducing artificial needs thereby creating "want".

It is our position that to handle such potential vested interest interference in the benefit-cost ratio, a technique must be devised that prevents essentially dysfunctional innovations from taking place. At the

same time the technique must avoid the simple substitution of one set of values for those of the vested interest groups. It is our position that the only way this can be accomplished is to use survival of mankind as a basic starting point and work from there.

Keeping in mind that man is a value oriented being, this means that we must tap the ordering of values in relation to his basic needs. Such a relationship has already been worked out by Maslow [240] who originally postulates five levels of needs. He notes that there is a hierarchical relationship among these needs which is shown in the following listing.

- "1. physiological needs, for example, hunger, thirst.
2. safety needs, for example, security, stability
3. belongingness and love needs, for example affection, identification
4. esteem needs, for example, prestige, self-respect
5. need for self-actualization." [240]

In this scheme one moves from the most pervasive to the more specific needs of man. It also incorporates a higher lower function in terms of the developmental nature of motivation. That is, a lower need (pervasive need) must be adequately satisfied before the next higher need can fully emerge. Such a scheme is highly compatible with the benefit-cost theory under development in the sense that to the degree persons or groups of persons are inhibited from achieving satisfaction of the higher needs, it represents a cost to the social system. The costs are evidenced when there is insufficient gratification of needs at any of the levels. This prevents emergence or full development of the next higher needs. In illustrating this process Krech, et al. [241] make the following observation.

"The man whose lifelong environment provides the barest essentials for physical survival is not likely to develop pressing needs for achievement, prestige, beauty. The chronically hungry man will never seek to build a brave new world. He is much too concerned with satisfying his immediate and pressing hunger needs. Only the person freed from the domination of his 'lower' needs can become motivated by other than deficiency-based drives. The ideal physical and social environment is therefore one that makes possible the gratification of each level of needs as it reaches its crest in the individual." [241]

While the emphasis in this passage is primarily concerned with the individual it is our position that many of these needs are systematically collectively denied to segments of any large population. Our thesis is that man primarily satisfies his needs in and through interaction in institutions. We now make the additional point that what is valuable to a person is that which has been determined to meet perceived needs.

It will be recalled that one of the major aspects of the theory of social action dealt with mobilizing of motivation for organized action.

In the benefit-cost theory under development, to the extent that this mobilization of motivation is lacking or systematically blocked for segments of the population, the cost factor is increased. We suggested earlier that a benefit-cost technology must be sensitive to the elements of the social system and to the processes articulating those elements. That is, the relative benefits or costs associated with new technological applications could be determined by examining its impact on the values, norms, mobilization process, and utilization and allocation of resources. It is also possible to assess them in relation to the processes of communication, systemic linkage, socialization, boundary maintenance, decision-making and social control. However, the outcomes will be quite different depending on the level, orientation and scope of the assessment. If the focus is on determining the potential effect on these elements and processes then the orientation is toward forecasting the result of the innovation's impact. If the technique focuses on structural and elemental changes, after the fact, then it is technically an impact analysis. We are concerned with creating a forecasting technique. Because of the relationship between the elements of social action discussed earlier, we are concentrating on the innovation's impact on values. Yet knowledge of the subsequent impact on motives is very important to a complete understanding of the social dynamics of adaptation, including its implications for both benefits and costs. Specifically, we are going into this area since it is often less apparent and the impact is less immediate. We consider such impacts as induced effects.

4. MOTIVATION

Motivation has been studied scientifically from a wide variety of perspectives. Hence, any general definition is likely to be somewhat incompatible with one of the many approaches. However, it is generally agreed that motivation represents a mobilization of energies within the organism which is selectively displaced on the environment. The difficulty in getting at motivation lies in delineating what it is that causes the mobilization of energies. Scientists have proposed a wide range of possible explanations including supernatural and rational processes, behavioral reflexes and tropisms, social and cultural determinism, unconscious impulses, biological drives and innate drives. Our own starting point is to accept the position that man, being a complex creature, is capable of experiencing a wide range of needs and hence of motives. However these are defined, they are nevertheless substantially influenced by learned cues from the environment. Still, quite apart from these cues, man can experience motivated states when there is no external input and when there are no biological deficiencies. One taxonomy which helps put the problem in perspective is through reducing the motive states to two primary types; survival and security motives (deficiency motives) and satisfaction and stimulation motives (abundance motives). The point is that both deficiency and abundance motives may be related to the same object. For example, the human body is the object of both survival motives (hunger) and satisfaction motives (seeking of pleasure). Krech, Crutchfield and

Livson [241] have integrated these two master motives into a single scheme which is presented below.

TABLE 8

The Human Motives

	Survival and Security (deficiency motives)	Satisfaction and Stimulation (abundancy motives)
Pertaining to the body	Avoiding of hunger, thirst, oxygen lack, excess heat and cold, pain, overfull bladder and colon, fatigue, overtense muscles, illness and other disagreeable bodily states, etc.	Attaining pleasurable sensory experiences of tastes, smells, sounds, etc.; sexual pleasure; bodily comfort; exercise of muscles, rhythmical body movements, etc.
Pertaining to relations with environ- ment	Avoiding of dangerous objects and horrible, ugly, and disgusting objects; seeking objects necessary to future survival and security; maintaining a stable, clear, certain environment, etc.	Attaining enjoyable possessions; constructing and inventing objects; understanding the environment; solving problems; playing games, seeking environmental novelty and change, etc.
Pertaining to relations with other people	Avoiding interpersonal conflict and hostility; maintaining group membership, prestige, and status; being taken care of by others; conforming to group standards and values; gaining power and dominance over others, etc.	Attaining love and positive identifications with people and groups; enjoying other people's company, helping and understanding other people; being independent, etc.
Pertraining to the self	Avoiding feelings of inferiority and failure in comparing the self with others or with the ideal self; avoiding loss of identity; avoiding feelings of shame, guilt, fear, anxiety, sadness, etc.	Attaining feelings of self-respect and self-confidence; expressing oneself; feeling sense of achievement; feeling challenged; establishing moral and other values; discovering meaningful place of self in the universe.

Perhaps foremost among the works attempting to organize these approaches is that of Maslow [240] which we just discussed. The most basic tenet of Maslow's scheme is that a fundamental motive of man is to express his potentialities in their most effective and complete form. The primary need underlying this approach is the need for self-actualization. A similar approach to motivation is found in the work of Robert White [242] who sees the basic motive as effectance. By this he means the attempt to interact with one's environment in a competent manner so as to effect changes which are rewarding to the individual.

Whatever one's view of motives happens to be one thing has been well documented, that is, that motives are subject to change. In other words, regardless of conception as to whether it is an inner push or an outer pull, changes in the environment affect motivations for human activity.

5. SOCIAL ADAPTATION

As we noted earlier, as persons are blocked from achieving satisfactions which are by definition available to them there is a cost to the social system. The question now remains as to how such blocking occurs and what expression the costs take. Both these questions involve complex issues and are incapable of direct and complete answers. This is partly due to the fact that reaction to such blocking is to a great extent also conditioned by the type block and the source of the block. Additionally, the reaction will be conditioned by the extent to which the block affects all members of a society or selects out phenotypes within the society for special treatment. One of the early social scientists dealing with this phenomenon is Robert K Merton. [243] Merton utilizes the concept anomie in developing his modes of adaptation theory. Anomie, defined as a breakdown in the normative functioning of a society, is used as an explanatorial variable in Durkheim's [244] theory of suicide. Merton sees anomie as the outgrowth of a disjunction between the cultural goals held out for all people in a society and the institutionalized means for attaining these goals. Some people are blocked from full participation in the cultural goals because of an inaccessibility of the means for achieving these goals. The resulting anomie requires the persons involved to adapt. The question is how does one adapt to this block. Merton's answer is embodied in the following scheme, where (+) indicates acceptance and (-) indicates rejection of the existing pattern. The rebel first rejects both (-) then substitutes his own (+) goals and means.

	Culture Goals	Institutionalized Means	
I. Conformity	+	+	
III. Innovation	+	-	
III. Ritualism	-	+	
IV. Retreatism	-	-	
<hr/>			
V. Rebellion	±	±	[243]

Criticisms of this scheme center around the notion that it isn't inclusive enough and that anomie isn't necessarily the outgrowth of the disjunction. Additionally, the Merton scheme deals only with the legitimate avenues for achieving success or cultural goals. In addressing this latter aspect of adaptation Cloward [245] suggests that deviant adaptations involve similar mechanisms. That is, the legitimate adaptive scheme posits that values serve to order the choices of both legitimate and deviant adaptations which develop under conditions of stress. In this sense, values exercise a canalizing influence, limiting the choice of both legitimate and deviant adaptations for persons variously distributed throughout the social system. Cloward makes the point that apart from both socially patterned pressures, which give rise to deviance, and from values, which determine choices of adaptations, a further variable should be taken into account: namely, differentials in availability of illegitimate means. The similarity of the process is well summed in the following observation.

"The availability of illegitimate means, then, is controlled by various criteria in the same manner that has long been ascribed to conventional means. Both systems of opportunity are (1) limited, rather than infinitely available, and (2) differentially available depending on the location of persons in the social structure." [245]

In a benefit-cost sense both legitimate and deviant adaptations are important. In the first instance, the degree to which the legitimate avenues for satisfying needs are blocked and introduce the need for adjustment behaviors (adaptations) which don't adequately meet needs, there is a "cost to the system". On the other hand, the extent to which persons choose deviant adaptations and illegitimate means for meeting these needs, a cost is similarly incurred. In both cases the adaptive behavior is motivated. However, the selective displacement of the behavior is conditioned by the value system and the availability of legitimate and illegitimate means. The optimal situation is one in which the system is open enough to allow for need satisfaction through legitimate channels and minimizes the "need" and "means" for deviant adaptations.

Another scientist, H. Taylor Buckner [246] expands the Merton typology by including the potential for deviant adaptations as well as legitimate ones. In this view there is a definite synthesis of the works of Merton and Cloward and Ohlin. In this view Buckner substitutes the term "symbolic universe" for Merton's "cultural goals". By this term Buckner wishes to connote legitimated social reality and offers this description definition of the term. The symbolic universe may be thought of "as containing, supposedly, reasons for everything. It orders phases of individual biography, keeps subjective identity straight...legitimizes the institutional order, sets limits on social reality...." [246]. In this expanded typology, therefore, the first variable is concerned with whether the individual or group seeks a value of a "legitimate" (symbolic universe). The second variable asks whether or not the individual or group behaves in accordance with a legitimated institution. The third concern is whether the behavior is more in accord with an illegitimate

value-normative institutional approach or a counter-institution. (Finally, the fourth) The fourth variable is concerned with whether or not the individual seeks a value of a completely different social reality. Each of these variables represents a choice in human behavior. While the typology concerns itself with individual adaptations as did Merton's there is every reason to believe that group and subcultural adaptations follow the same processes.

Expanded Typology of Individual Adaptation [246]

Sym- bolic Uni- verse	Legiti- mate Insti- tution	Alter- nate Re- ality	Count- er Insti- tution	Mer- ton's type	Expanded Types	Description
+	+	+	+		1.	Person who believes in contradictory values and is in contradictory institutions.
+	+	+	-		2.	Contradictory values, conforming behavior.
+	+	-	+		3.	Believes in symbolic universe, does legitimate and illegitimate things.
+	+	-	-	Con- formity	4.	Conformity.
+	-	+	+		5.	Contradictory values, counter-institutions.
+	-	+	-		6.	Contradictory values, no institutions. Behavior at "habit" level.
+	-	-	+	Inno- vation	7.	Counter-institutional behavior.
+	-	-	-		8.	Residual rule breaker. Behavior at "habit" level.
-	+	+	+		9.	Pluralist evolutionary. Rejects only conventional values.
-	+	+	-		10.	Belief in new values for old institutions.
-	+	-	+		11.	No values, does legitimate and illegitimate things to get by.
-	+	-	-	Ritu- alism	12.	Ritualism.
-	-	+	+	Rebel- lion	13.	Revolutionary.
-	-	+	-		14.	Belief in new values, behavior at "habit" level.
-	-	-	+		15.	Asocial institution. Behavior that "just grows" outside of any reality.
-	-	-	-	Re- treat- ism	16.	Believes nothing, does nothing. Cloward's "double failure". Behavior at "habit" level.

Buckner elaborates on each of the types of adaptations in the following series of examples.

1. ++++ A person who finds himself believing and acting in contradictory social realities. This would be a very uncomfortable position, and I imagine there would not be many people who could do it for long. A factory owner who works for socialism at night might be an example.
2. +++- A person who believes in contradictory values, but whose behavior is conventional. A factory owner who believes in socialism but doesn't do anything about it might be an example.
3. ++-+ A person who believes in conventional values, but does both legitimate and illegitimate things. The man who works by day and steals by night.
4. +- - A conformist. A person who does not have a reality-experience conflict.
5. +--+ A person who is involved in an alternate reality and a counter-institution but still believes in an old and contradictory value. A socialist revolutionary who believes in free enterprise.
6. +-+- A person who believes in contradictory values but is involved in no institutionalizations of behavior. This sort of person might be socially defined as a catatonic schizophrenic, or possibly a mystic.
7. +--+ A person who achieves conventional goals through counter-institutional behavior. This is a very frequent adaptation and we will study many examples.
8. +--- A person who believes conventional things but who breaks various rules of behavior because he does not follow institutions of behavior, but only his own habits.
9. -+++ A person who does both legitimate and illegitimate things but rejects conventional values. For example, a hippie who would reorganize values but who drinks alcohol as well as smoking marijuana.
10. -++- A person who behaves conventionally but who believes in a different organization of reality.
11. -+-+ A person without values who does legitimate and illegitimate things in order to get by. The "rounder" mentioned in Chapter 4 might be an example.
12. -+-- The ritualist, who does what he is supposed to but doesn't believe in anything. A person who just goes through the motions required by the institution of behavior.

13. --++ The classic revolutionary, one who wishes to sweep away the old institutions and values and substitute new institutions and values. A person living in an alternate reality.
14. --+- A person who believes in the values of an alternate reality, but who does not participate in legitimate or illegitimate institutions, following only his own habits.
15. ---+ Asocial institutionalization. A person who participates in an institution of behavior that is not explained by legitimate or illegitimate values. Such institutions will probably be defined, eventually, as either legitimate or illegitimate.
16. ---- A person who does nothing and believes nothing. A person who has withdrawn entirely from some aspect of social reality. The ultimate withdrawal from society may be suicide or "voluntary death".

The question of choice of adaptation becomes more focused when the availability of legitimate avenues is introduced. However, many persons or groups of persons while being in the society are structurally forced to live outside its legitimate offerings. This portion of the population constitutes a real problem to legitimate society in that it affects the motivational and resource utilization facets of the conforming population. In a less evident fashion it also affects the values and conformity to their normative traditions. In this sense they constitute a cost to the total society.

Some may object on the basis that anomie affects only a small number in any society and, hence, isn't a good explanatory variable. However, anomie is considered by many social scientists as a variant form of alienation and that the major blockage to participation may well be one or a combination of the variant forms of alienation. Of the many scientists who speak of this concept perhaps none is more illuminating than Melvin Seeman's "On the Meaning of Alienation". [247] However, several other words preceded his own. In the works of both Karl Marx and Emile Durkheim the concept alienation is present. Richard Jessor [248] identifies both these authors as contributing to the definitional currents which surround the present status of the alienation concept. Marx's concern with alienation centered around his concern for the social and personal consequences of the complex industrialized process of production. Durkheim's use of the concept is embodied in his own term "anomie". Jessor, in commenting on the useage of the term alienation, points out that the useage of the terms alienation and the psychological use of the term anomie have in common their reference to a personal or individual state which is presumed to reflect a social condition. Both these viewpoints are decidedly sociological. However, the concept has been treated from a psychological viewpoint by many researchers one of whom tested the concept in a research setting. We refer specifically to the "Srole Anomia Scale" developed by Leo Srole [249] which is intended as a psychological measure of anomie as subjectively measured. Several persons including Richard Jessor have

indicated that the scale development by Srole is an extension of the definition MacIver has given of anomie.

"Anomy (sic) signifies the state of mind of one who has been pulled up by his moral roots, who has no longer any standards but only disconnected urges, who has no longer any sense of continuity, of folk, of obligation...The individual's sense of social cohesion--the mainspring of his moral--is broken or fatally weakened." [249]

The first real historical and detailed view of the concept "alienation" has been given by Melvin Seeman as noted above. In this work Seeman outlines five different but related useages of the term. Briefly, the useages are as follows:

"Powerlessness, is a variant of alienation which Seeman conceived of as: the expectancy or probability held by the individual that his own behavior cannot determine the occurrence of the outcomes, or reinforcements, he seeks." [247]

The second type of alienation in this viewpoint, meaninglessness, refers to the individual's sense of understanding of the events in which he is engaged and may be operationalized by focusing on the fact that it is characterized by a low expectancy that satisfactory predictions about future outcomes of behavior can be made. [247]

When speaking of "normlessness" which is the third distinct variant of alienation, Seeman addresses, he uses Merton's lead and characterizes this situation in definitional terms as existing when; "there is a high expectancy that socially unapproved behaviors are required to achieve given goals". [247]

Those who are alienated in the fourth sense--isolation-- "are those who, like the intellectual, assign low reward value to goals or beliefs that are typically highly valued in a given society". [247]

The final variant treated by Seeman is "self-estrangement" which is acknowledged to be difficult to define. However, he states: "One way to state such a meaning is to see alienation as the degree of dependence of the given behavior upon anticipated future rewards, that is, upon rewards that lie outside the activity itself." [247]

There have been several authors who have investigated social situations employing one or more of these particular variants of alienation though none appear to have contributed much in the way of clarifying the basic five variants outlined by Seeman. One good example of this assertion can be found in an article by Robert Blauner [250] wherein he uses the self-estrangement variant of alienation to view the role of the factory worker.

However, the summary of the concept of alienation offered by Jessor is very insightful. His aim was to review the implications of the term alienation in order to make it a more useful concept for research. He arrived at three general conclusions which are as follows.

"First, a term was needed on the psychological level to refer, with minimal confusion, to what could be considered as the subjective counterpart to the objective sociological condition of anomie. For this purpose, we have eschewed all variants of the 'anomie' term, such as 'anomia', 'subjective anomie', and 'psychological anomie', in favor of the term 'alienation'. Second, the psychological term alienation should refer to a fairly generalized view or perspective held at a mostly conscious level and describing the individual's appraisal of his general life situation. Third, the term should refer to a syndrome of relatively co-varying attributes rather than to any single one. Finally, the core aspect of the syndrome, the aspect which has received the most general emphasis from various scholars and which seems to unify the constellation of associated attributes, is the idea of the sense of social connectedness or isolation." [248]

For our purposes the idea of alienation as a syndrome is important. For it includes within it the notion that the alienated person is one who has been estranged from his society, one who has been made unfriendly toward his society and the culture it carries. This point was made by Nettler who was also concerned with measuring alienation. [251] It is also this same notion that has been carried over in Jessor's approach. In his approach the dimension of social isolation includes isolation in the sense of being rejected, excluded, or repudiated in social relations. However, in recognizing the syndrome quality of alienation Jessor has also included two other relevant aspects; "the feeling of lack of gratification in ordinary day to day activities and the feeling of pessimism about the future. The alienation syndrome, therefore, has the character of being part of the personal belief structure and referring generally to the individual's sense of social isolatedness and his estrangement from basic life roles". [248]

Srole found in his study of Midtown [249] a definite relationship between an individual's mental health and his socioeconomic status. These in turn were found to be related to the person's personality pattern and style of adaptation. These styles of adaptation were found, for example, to involve the displacement of aggression. The upper socioeconomic groups used a repression device and tended to turn the aggression inward while the lower classes tended toward violent releases. There is in fact a considerable body of evidence which shows that the frustration tolerance level varies by class status.

The point that's made with respect to a benefit-cost analysis is that mobilization of motivation almost certainly varies with position in the social status system. Additionally, evidence from social research and a rather large body of social theory points to the fact that alienation also

varies with position in the social status hierarchy. The sources of alienation, as just noted, are much more varied than the concept anomie implies in as much as this latter concept is treated as a structurally induced phenomenon.

In a benefit-cost analysis a lack of motivation for whatever reason (cultural, psychological, or sociological) and increases in alienation represent definite and serious "costs" to the society.

XIII. STRESS: ANOTHER POTENTIAL COST

1. INTRODUCTION

Another area of human adaptation totally excluded from traditional benefit-cost analyses is also related to alienation and its warrants, namely, stress. Stress is one of the more intangible type costs that will may turn out to be quite critical in terms of both survival and the quality of life. This facet emerged in the present work after extensive examination of the adaptations people make to natural disasters. Stress in these studies emerges as both an intangible and induced effect. Hence, social stress is considered as it relates to a wide range of adaptive diseases. The concept of stress is unique and only treated scientifically for a short period of time. Hence, we will present information of both a historical and developmental nature before delving into the important findings of stress research.

2. HISTORICAL PERSPECTIVES

In recent years biologists, psychologists, psychiatrists, sociologists, and physicians have begun to study the physical effects of environmental stress and its relationship to disease. This relationship, however is not a new one and can in fact be found in historical writings as far back as Hippocrates.

Hippocrates observed that disease involves not only a "pathos" (suffering), but also "ponos" (toil or struggle). The illness is, he believed, the struggle of the body to adapt to sudden changes in its environment. In his writings he warned repeatedly against the danger of violent change - in climate, in season, in diet, or in mode of life. [252]

One of the problems in attempting to place the study of stress into a proper historical perspective arises from the many guises the study has taken. For example, the following works all consider stress, though they are not addressed specifically to the concept of stress:

"The defense by conditioned reflex theory of Pavlov the defensive neurosis theory of Freud, the fight-or-flight theory of Walter Cannon." [252]

It should be noted that these works are distinctly psychological in nature and content.

Possibly the second most difficult problem in bringing stress, as a concept, into a proper historical perspective stems from the lack of a precise definition. It is quite likely that the first person to introduce the concept stress, as a concept, into the life sciences was an endocrinologist, Hans Selye. This occurred in 1936. This claim has in fact been made by Appley and Trumbull [253], who further state that the wide appeal of the concept was evidenced by the fact that the literature on its primarily physiological aspects alone was close to six thousand publications per annum by the early 1950's.

Selye was a medical student Prague, when he first noticed what he has since called "the syndrome of just being sick".

"Patients with all kinds of infectious diseases had, at the onset, much the same symptoms: diffuse aches and pains, coated tongue, intestinal upset, and loss of appetite. They often had fever, mental confusion, and enlarged spleen or liver, inflamed tonsils, a skin rash. Yet Selye's professors dismissed these symptoms as "nonspecific and of no use in diagnosis". The young doctor was directed to wait for a specific sign -- the swollen parotid gland of mumps, the muscle paralysis of polio, the jaundice of hepatitis -- before making a diagnosis. Even today, few would disagree with the Prague professors -- yet in those nonspecific symptoms lies a clue to a new concept of disease and health." [254]

However, Selye did not at this particular time notice anything more than the commonality of these symptoms. He did ask himself why it was that such widely different disease producing agents as those that cause measles, flu, etc. share with a number of drugs, the property of evoking the manifestations just cited. He says:

"I could not understand why - ever since the dawn of medical history - physicians should have attempted to concentrate all their efforts upon the recognition of individual diseases and the discovery of specific remedies for them without giving any attention to the much more obvious "syndrome of just being sick". I know that a syndrome is "a group of signs and symptoms that occur together and characterize a disease". The patients we had just seen had a syndrome, but this seemed to be the syndrome that characterized disease as such, not any one disease." [255]

Selye's first real big discovery did not come until 1946. At this time he was working in the Biochemistry Department of McGill University, attempting to find a new ovarian hormone in extracts of cattle ovaries. His observation made during these experiments was that:

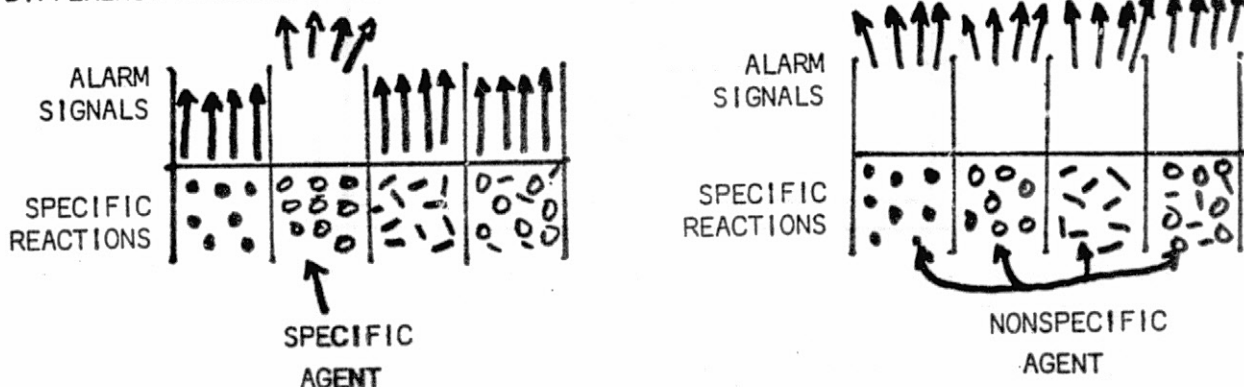
"... all the extracts, no matter how prepared, produced the same syndrome, characterized by enlargement of the adrenal cortex, [255] gastrointestinal ulcers, and involution of the thymus and lymph nodes. Although at first I ascribed all these changes to some new ovarian hormone in my extract, it soon turned out that extracts of other organs, in fact even toxic substances of all kinds, produced the same changes. It was only then that I suddenly remembered my classroom impression of the "syndrome of just being sick". "...I realized that what I had produced with my impure extracts and toxic drugs was an experimental replica of this condition; this model was then employed in the analysis of the stress syndrome, using the adrenal enlargement, gastrointestinal ulcers, and thymicolymphatic involution as objective indices of stress." [255]

The real importance of this discovery lies in two areas. The first is that it provided an objective basis for the development of the entire stress concept in the sense that it provided objectively measurable indices. Secondly, it provided a great impetus for future research as has been evidenced in the great number of volumes appearing on the topic of stress.

The difference between specific and non-specific agents causing a stress reaction is shown in the following figure.

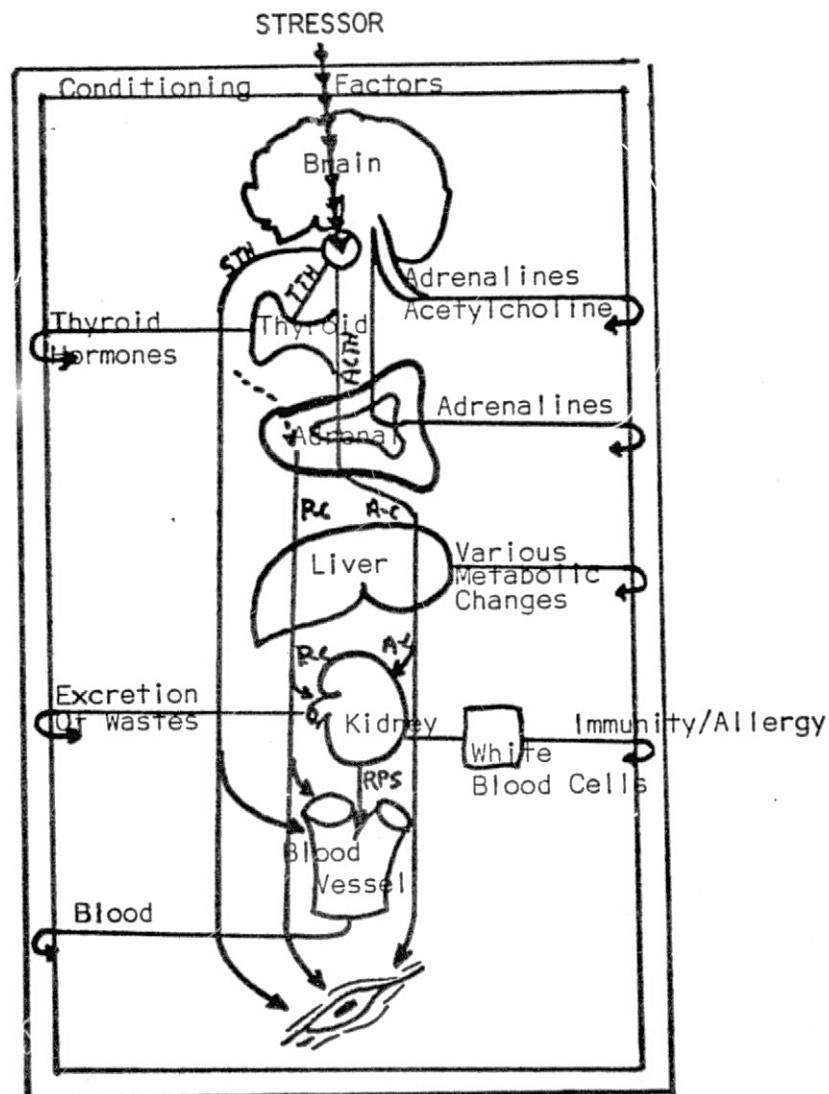
Figure 68.

DIFFERENCE BETWEEN SPECIFIC AND NONSPECIFIC AGENT



Perhaps it will be easier to grasp the thrust of Selye's work, if a model of man is used. In this presentation the stressor is something external to the host. However, everything within the main frame represents a complete human body. The conditioning factors (heredity, previous exposures, diet, etc.) are symbolized by the frame within which all reactions must develop. The main regulators of the stress syndrome (brain, nerves, pituitary, thyroid, adrenals, liver, kidney, blood vessels, connective-tissue cells, white blood cells) are each represented by special symbols. The interactions between these main regulators are shown in the usual way by connecting arrows. The autonomic system is

Figure 69.



not shown. In this general diagram an attempt is made to show the fundamental pattern of all stress-situations. That is, the stressor is not shown as acting upon any one target area in particular. We merely indicate that wherever it happened to act first, it eventually produced generalized stress reactions in the whole body. This generalization of response is accomplished through two systems: the nervous and endocrine.

While at this point we are leaving the discovery of Selye still largely unexplained, we will consider his theory, which came to be known as (GAS) General Adaptation Syndrome, in the section on response to stress. Our aim thus far has been to show that stress, even though not labeled as such, has been a concept associated with disease for a long time.

3. DEFINITION OF STRESS

Much of the problem in obtaining a proper historical perspective when dealing with stress was found to stem from an absence in the usage of the term itself, that is, the studies and theories concerned with stress appeared under many guises. However, even after the introduction of the concept stress there remains a certain ambiguity. This ambiguity stems from the multitude of conceptual definitions.

As nearly as can be determined the term "stress" originated in the field of engineering and many of the later uses of the term reflect this. For example, Thomas Langner [256], in Life Stress and Mental Health, writes:

"Our use of these terms (that is, stress and strain)* will be similar to the engineering usage, particularly in testing the strength of materials.

In designing any structure or machine the engineer must first determine the amount and kind of stress the various parts will be required to withstand; and he must know how the various materials will react when subjected to a known stress ...

Stresses which the parts of a structure or machine may be called upon to resist include tensions, compression, shearing stress and torsional stress. Strain is the deformation, or change of shape, produced by stress." [256]

This definition is quite important in relation to the overall scheme of the Midtown Manhattan Study from whence it came. [249] It is important in the sense that it is the underlying conceptual framework upon which the multi-factoral model of stress and disease, which they use in the study, is built. This will be dealt with in the section on social models of stress as an etiological variable.

One more aspect which this definition of stress points out is its twofold nature. First, there is a noxious agent or a "stressor" and, secondly, a consequent reaction to that agent. In all definitions of stress that we have examined, with possibly one or two exceptions and these occurring in limited applications, this twofold aspect appeared. Much of the confusion in defining stress stems from placing an emphasis on one or the other of these two aspects. For example, Hans Selye appears to have been instrumental in reversing the engineering convention for the language of stress that we just cited.

* Parenthesis added.

"He refers to the "noxious" stimulating condition which produces stress reactions as the "stressor", while the state of the animal itself, the reaction, is called stress. It might be noted in passing that sometimes Selye uses the term "stress" to refer to the initial impact of the stressor on the tissues (the alarm stage), sometimes to the adaptive mechanisms whose function it is to restore homeostasis, and sometimes to the wear and tear, damage, or disease consequences of prolonged homeostatic process. There are at least three meanings here to the term "stress" even though it always refers to the state of reaction of the animal's tissue systems to the stressor or noxious stimulus." [257]

Lazarus' point is well made, for in fact Selye does use terminology which is a reversal of the engineering model. More important, however, is the underlying reason for these comments. For if, in fact, there is ever to be conceptual clarity concerning the definition of stress, then there must be some consistency in terminology.

The third conception of stress comes from the work of Walter B. Cannon. [258] Who proposes a homeostatic model which subsequently has received much attention by the psychologists. This attention has occurred in spite of the fact that there is not suitable means of specifying the steady state condition to which the psychological system returns when it has been disturbed. Also, there have been sociological analyses using the homeostatic view. Notably Smelser's [171] theory of panic and riot employed such a model.

Lazarus [257] sees the homeostatic point of view concerning stress as follows:

"... a stress is some stimulus condition that results in disequilibrium in the system and produces a dynamic kind of strain, that is, changes in the system against which mechanisms of equilibrium are activated." [257]

While psychologists and sociologists have applied the homeostatic model to some of their research it should also be pointed out that this concept is central to the physiologist's conception. For example, Selye's adaptation syndrome, which is an elaborate series of neural-hormonal reactions against the effects of noxious agents on the tissue system, is implicitly based on the bodies tendency to achieve homeostasis.

In summarizing what we have stated thus far, two points become clear. The first is the quite obvious fact that much of the confusion in defining stress results from the host of proposed definitions and the lack of an agreed upon terminology, that is, there exists a lack of conceptual clarity and definition among most of the prominent theorists.

The second point appears, on the surface at least, to be equally as obvious. This is the observation that there is a two sided aspect

in each of the definitions or conceptual models we've presented. On the one hand, there is the stressor side of the model, that is, "stress" to Langner's model and "stressor" to Selye's. Lazarus proposes that this side of the model be referred to as the "stimulus" side. [257] This stimulus side is further seen as being composed of environmental pressures from the external environment or from the internal environment, or both. On the other hand, there is the "strain" side of Langner's model and the "stress" side of Selye's model. This side is seen as a reaction to the environmental pressure. Lazarus refers to this side as the response side and notes that it refers to the nature of the stress response.

When Lazarus addresses the confusion resulting from this latter problem he attempts to outline it in such a way as to reduce the confusion resulting from terminology and present the dual aspect of the stress model.

"Regardless of terminology, the same theoretical and empirical problems face us. We must identify the external and internal forces or stimulus conditions of stress reactions, and the intervening structures and processes that determine when and in what form the stress reactions will occur." [257]

Of the many social and psychological definitions examined, that of Langner [256] appears to be most consistent with these underpinnings.

"A stress may be any influence, whether it arises from the internal environment or the external environment, which interferes with the satisfaction of basic needs or which disturbs or threatens to disturb the stable equilibrium." [256]

This definition and theoretical conception of stress strengthens the possibility of isolating the connection between certain stress inducing stimuli in the environment as an etiological variable and diseases or pathological reactions. In order to help demonstrate this a distinction is made between the stimulus and response sides of the model. It is evident from the literature that both sides of the model have been studied extensively.

4. STIMULUS SIDE OF THE STRESS MODEL

While it would certainly be an ideal situation to be able to isolate a direct causal link between one stress variable or stressor unit and a given reaction or disease, it appears highly unlikely at this point in time. This low probability stems partially from the fact that stress is a very relative concept. Selye brings this aspect to light in his definition of stressor. [254] "The stressor is naturally 'that which produces stress' ... it is also self-evident that any one agent is more or less a stressor in proportion to the degree of its ability to produce stress, that is, nonspecific changes." [254]

The likelihood of creating a monocausal model is limited by the relativity of the stress concept. A multiple causality model appears to be much more likely. Selye notes this point in his statement: "Stress shows itself as a SPECIFIC syndrome, yet it is NONSPECIFICALLY INDUCED." [254] This same emphasis on a multicausal model is considered by Stanley King.

"When the impact of the social environment in the etiology of illness is considered, the assignment of a direct cause is often difficult if not impossible. Causal pathways must be inferred rather than demonstrated, so that psychosocial factors in etiology must at the moment remain a topic characterized more by conjecture than by certainty." [259]

With these distinctions in mind, an attempt is now made to illustrate some of the different ways in which the psychosocial variables may be associated with disease or pathology. An attempt is made to keep the distinction between stimuli from within or the internal environment and those in the external environment. The first consideration is of the internal environment, or of stress situations in which the interaction of the individual with his interpersonal environment produces emotional reaction and/or conflict with an accompanying alteration of his physiological balance.

In most studies of the internal environmental stimuli, the primary interest of the research scientist is in individual factors, but with the aim also of making generalizations that can apply to groups of individuals. More often than not the research technique is the clinical method. [259] Psychological stress is interpreted as being an intrapersonal functioning which is severely disturbed. This disturbance can occur from such diverse happenings as suffering a loss, be it of his love, his job, or his fortune, or when he cannot achieve what he wants. This discontinuity in his normal functioning brings the organism under an extra heavy load causing a physiological reaction to occur.

There is a distinction that should be made at this point to avoid confusion later on. There exists a tendency to confuse the terms psychological and emotional stress by equating them. Magda Arnold [260] makes the distinction on the basis that psychological functioning is primary, in the sense that any blockage or disturbance occurs in the psychological functioning of the organism. The emotional aspect is a secondary phenomenon, in the sense that it doesn't enter in to support the organism until a certain stress level has been attained. [260] Arnold proposes this difference as a very essential one in the study of stress. She first describes the subjective nature of stress showing that in any situation the person will interpret the stimuli and evaluate it relative to itself. When the threat to the organism is sufficient it will produce the necessary emotion to overcome the threat. The emotion could be fear, anger, confidence, courage or many others depending upon the interpretation. [260] This aspect of the internal definition and interpretation can likewise be instrumental in increasing the stress and its consequences, in the sense that it may start a vicious circle interaction into motion.

There have been a few research projects attempting to determine the effects of psychological stress on human functioning. However, the vast majority of the studies attempting to correlate stress and physiological reactions have been performed by animal psychologists using rates or monkeys. One study conducted on human participants worth noting was performed by two English doctors, F. C. Greenwood and D. J. Landon. They performed an experiment on medical students. They became interested in the possibility that stress affects growth hormone when a medical student reacted to an experiment in which he was given upsetting false information.

"He was told that he had received a large dose of insulin and that he would experience severe symptoms caused by a fall in blood sugar, or hypoglycemia. In reality, a salt solution and not insulin had been injected. Although his blood sugar was unaltered there was demonstrable increase in his growth hormone as well as in his plasma hydrocortisone (cortisol).

Saline injection in four control subjects, who had not received any disturbing information, produced no changes in plasma sugar, cortisol or growth hormone.

To prove further that growth hormone increases with stress, the scientists induced stress with a pyrogen, a substance that causes fever, in two males and two females.

The results suggest that a fever induced stress stimulates both pituitary growth hormone and ACTH secretion not due to a measurable fall in blood sugar. Plasma sugar levels were unchanged in both men and women. The growth hormone response to a pyrogen appears to involve a different mechanism not before demonstrated since it was not suppressed by a continuous intravenous infusion of glucose. [261]

This experiment is important to our consideration in two senses. First, it is a study of human response to an internal psychological stress. Secondly, it demonstrates that biological stress, i.e., an internal biological malfunction, similarly produces a physiological reaction.

We had previously mentioned that the great majority of the studies correlating stress and physiological reaction were performed on animals. The general patterning of these type stress experiments finds the experimenter manipulating the environment in a manner intended to produce a response, and then measures the extent and/or direction of the behavior change produced. It should be noted that this is the typical pattern for all psychological experiments. Stress studies are usually distinguishable primarily in the selection of stimulating conditions.

The real problem involved in applying results of psychological stress experiments performed on animals to the person is the vast phylogenetic difference. Lazarus points to two general principles which state the general ways in which lower forms of animal life differ from higher forms.

"The first is: As we go up the phylogenetic scale, behavior is increasingly dependent on learning and less on instinctive, built in mechanisms. This rule of phylogenetic development means that in higher animals the conditions that produce stress reactions are less dependent on the direct physical impact of stimuli and more dependent on cues that signify meanings to the animal, meanings about the implications and consequences of these cues ...

The second principle is a derivative of the first. It states: As we go up the phylogenetic scale, everything becomes more diverse, more variegated among different individual specimens. Stress reactions are produced by more varied stimuli in higher than in lower animals. Because of his unique experience and the great role played by learning, language, and thought in governing his reactions, the individual human being may respond with stress reactions in the presence of a cue that results in little or no stress response in other persons ... [257]

The work of psychologist J. V. Brady, et. al. [262], in which they correlated stress and ulceration in rhesus monkeys, is possibly of extreme importance relative to humans. However, at this stage of our own intellectual evolution and the phylogenetic differential known to exist between monkeys and humans, any attempt at drawing a direct relationship between stress studies performed on lower animals and humans would be open to serious question. It might also be added, that this phylogenetic distinction holds for studies correlating environmental stress and physiological reaction. Lazarus notes this point in his statement:

"The interpretation of the significance of environmental events is decreasingly involved in stress production as we go down the phylogenetic scale. [257]

The external environment, however, is of extreme importance to the study of stress and disease in humans and for a host of reasons. First it should be noted, however, that in our separation of internal and external environments there appears to be an implication of non-relatedness. This is definitely not the case. For, as we have pointed out in the discussion of a phylogenetic difference, the human because of his development is able to be stimulated or "stressed", as the case may be, by cues from his external environment. In fact it is generally the stressor from the external environment which causes the psychological or internal environment to start an interaction process into motion and then the "stressor" becomes compounded in the sense that, while the initial stressor existed in the external environment the consequent interaction with the psychological aspect of the human introduces the internal environment into the process and compounds the stress. Note, however, it is not necessarily a compounding of stress, it may also be a reduction of neutralizing of the external stimuli.

Studies on stressors in the external environment have identified a multitude of variables. However, the difficulty in stress studies is not so much in identifying the variables, since almost any other person, group, or social association, as well as temperature, weather, etc., can be stressful at some given time. Rather, it is being able to determine what variables, under what conditions, will be stress producing and consequently lead to illness in the host. A few studies are included to illustrate the external environmental factors as it would be nearly impossible to present a complete history.

The first of these studies was conducted by two young doctors from the Cornell Medical Center, William N. Christenson, and Lawrence E. Hinkle, Jr. They performed a three year study correlating stress and sickness in healthy young men in relation to a socioeconomic background. Their sample size was 139 men, aged 22-32, who held low rung executive jobs in a big corporation. Their types of work, income, and behavior patterns were much the same. They differed only in education with 55 being college graduates and 84 high school graduates only. [263]

In spite of all the outward similarities, the difference in background was decisive when it came to disease. During the course of one year, the high school graduates suffered half again the number of illnesses as did the college graduates. Though few of these involved risk of death, the risk run by high school graduates was ten times that of the college men. Above all, many more of the high school men showed telltale signs of future cardiovascular disease.

The crucial factor in these differences turned out to be stress. The high school men faced daily a much greater proportion of stress in family life. They married earlier, had more domestic problems and found adjustment to life in a big corporation much more difficult. [263]

Similar findings have been found in some of the studies correlating social factors and mental breakdown. For example, Pollingshead [264], in research done in 1962 drew a link between stress and mental breakdown. The main theory was that the stress of the socioeconomic milieu in which the average American worker finds himself is a contributory factor in the incidence of psychotics and schizophrenics, these being the extreme cases. A much higher number of the group were found to be characterized by minor neurotic traits such as compulsion, aggression, hypochondria.

Saad Nagi, conducted a study using socioeconomic stress as a variable in relation to arteriosclerotic heart disease. He interpreted the results of the study which was conducted among rural populations in Ohio in view of the general hypothesis linking occupational and emotional stresses to arteriosclerotic and coronary heart diseases and found a significant relationship. The incidence of stress is definitely correlated with heart disease.

In order to show the breadth of variables that are possible, we have selected as a final illustration the following statement from Stanley King.

"Of special interest is the effect of the social milieu on nutritional factors, seen in terms of the limitation on available foods by the nature of the climate or soil, by the economy of the society or by the customs of the social group ...

Cultural taboos can also be important indirect factors in illness. An individual may be blocked by these taboos from getting the proper information about avoiding illness. Control of syphilis and gonorrhea for example ...

Social change and the disruption of established cultural patterns may bring about many conditions that are conducive to illness." [259]

The purpose in presenting this section on the stimulus side of stress model has not been to isolate variables that can be called "stress producing" regardless of their genesis, i.e., internally or externally created. Rather, it has been to present an overview of the area with the hope of showing two things. First, and most obvious, is the great diversity of the possible stressors in both the internal and external environment. Secondly, and more importantly, is the strength of the over accumulating body of evidence which is linking, in a causal way, stress to illness (disease) and show evidence that this experience varies along phenotypic dimensions. Perhaps a comment should also be made about the importance of a conceptual model of disease. For social milieu factors do not fit easily into a conception of causality if considered in light of a conceptual model of direct causality. But could fit nicely into a multifactoral model for which there is evidence mounting and applying pressure for this type change, especially in the area of stress and disease. The creation of the phenotypes utilizes this some multifactoral model.

5. RESPONSE SIDE OF THE STRESS MODEL

According to Lazarus [257], there are four main classes of reaction which have been used to index stress. These are: reports of disturbed affects, motor-behavioral reactions, changes in the adequacy of cognitive functioning, and physiological changes. The concern here is primarily with the latter in the sense that every illness represents a physiological change in body functioning. This category is one of the most widely used classes of indicators of stress reaction.

"... This includes reactions of both the autonomic nervous system ... and of the adrenal glands which secrete various hormones under stress. Biochemical studies of adrenal cortical secretions have been greatly stimulated by the research of Selye [254]. Some of the recent studies of plasma and urinary corti-costeroid levels in response to psychological stress have been summarized by Hamburg [1962] ...

With respect to the autonomic nervous system, many end-organ responses have traditionally been studied as indicators of stress, including GSR (Galvanic Skin Response), blood pressure, heart rate, respiration, and skin temperature, to mention the most common ... Autonomic nervous system research has close links with the field of psychosomatic medicine, or "stress disorders", as the psychophysiological effects of stress that produce clinical symptoms ... Even congestive heart failure has been considered a result, in part, of processes generated by stress in a susceptible individual. [257]

The comments by Lazarus tend to illuminate the scope of the research that has been done in the physiological response to stress side of the model.

In our own description of the response side of the model we are going to concentrate heavily on the research of Hans Selye whose work has centered mainly around the endocrine system. This will be followed by a few studies which have centered on the autonomic nervous system.

It will be remembered that Selye has defined stress as the response to a stressor. However, this is not a complete definition and it will be advantageous to present Selye's definition at this time.

"Stress is the state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biologic system". [254]

Selye is attempting to construct an operational definition which tells what must be done to produce and recognize stress. It is his contention that a state can be recognized only by its manifestations. In the case of stress, the recognition comes from the manifestations of the stress syndrome. This requires a change in thinking, for previous conceptions of a specifically induced change by only one agent must be rejected. In its place there must be substituted the idea of a nonspecifically induced change caused by many agents. This is a picture of stress which Selye labels G.A.S. (General Adaptation Syndrome).

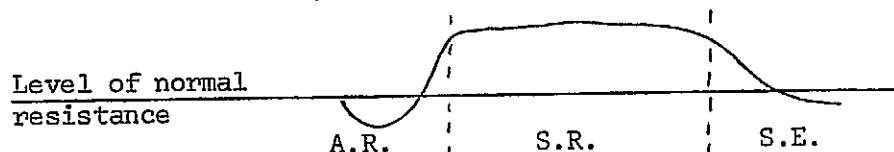
There is one distinction which must be made concerning Selye's definition and this is in relation to the nonspecificity of the induced change in the biologic system. In the biologic system nonspecifically formed effects are quite common; but highly selective effects upon circumscribed parts of the body are produced by comparatively few agents. As an example, wastage of body tissues is induced by starvation, infectious diseases, emotional upsets, cancer, and by many other conditions, but a truly selective and intense stimulation of the adrenal cortex can be produced only by one hormone: ACTH. In this respect the stress-response differs from most other biologic reactions, because it is nonspecifically produced and yet, its form is quite specific. [254] This may be clarified somewhat if we demonstrate what is meant through an example.

The nonspecific induction of change may be any stressor in either the internal or external environment, e.g., when organs are induced to function intensely or when tissues are damaged, for instance a burn on the skin, which sends a chemical alarm to the brain. This all applies to the nonspecificity of induced change in that it can come from a host of variables. The next step is a generalized mobilization of the bodies defense mechanisms. There is an increase secretion of ACTH, which is the adrenal-stimulating pituitary hormone. This substance, in turn, stimulates the adrenal cortex which causes a rise in the cortical-hormone content in the blood. This part of the alarm response, that is, the selective secretion of ACTH and corticoids, is a specific form of response. Its purpose is to increase the production of corticoids, which can then act back upon the stimulated area, i.e., the area of the burn in our example, to steady its work and put out the fire of excessive activity. [254]

The final comments on Selye's work is centered around the general adaptation syndrome. In a tracing of the development of G.A.S. over a period of time, it is found to consist of three phases.

"To illustrate this I pointed out that if an animal is continuously exposed to some stressor (say, cold), the adrenal cortex first discharges all its microscopic fat-granules which contain the cortical hormones (alarm reaction), then it becomes laden with an unusual large number of fat-droplets (stage of resistance) and finally it loses them again (stage of exhaustion). As far as we can see the same triphasic course is followed by most, if not all, of the manifestations of G.A.S.

The next figure illustrates this graphically, using general resistance to injury as an indicator.



In the acute phase of the alarm reaction (A.R.), general resistance, to the particular stressor with which the G.A.S. had been elicited, falls way below normal. Then, as adaptation is acquired, in the stage of resistance (S.R.), the capacity to resist rises considerably above normal. But eventually, in the stage of exhaustion (S.E.), resistance drops below normal again. [254]

It is hoped that this view of the general adaptation syndrome has served to show two things. First the two step process which the stressor causes, that is, one the alarm reaction which produces, two, the secretion of the hormonal corticoid defenses into the blood stream. Secondly, it is hoped that this will serve to clarify Selye's insistence on using a response

type definition of stress, which generally stems from the fact that you can't determine whether or not the organism is under stress until there is a presence of the syndrome.

Selye has concentrated his research mainly in the adrenal area. However, he recognizes the important function the nervous system plays. This is especially important because he sees the twofold nature of the alarm reaction system. That is, a stressor acts upon the body causing a generalized stress-reaction. This generalization of the response can be accomplished by way of the two great coordinating systems: the endocrine and the nervous.

When pointing to the importance of the nervous system, he states that, "the stressors, acting through the nerves, produce adrenalin and acetylcholine which can influence the G.A.S. - mechanism selectively at any point." [254] The important aspect to be grasped is the selective function the nervous system plays in influencing the entire G.A.S. This brings us directly into the area of psychosomatic illness. Rather than attempting a technical demonstration of how this operates, we are going to present a couple brief studies to show the direction the research has taken.

The first of these studies was conducted by Joseph Brady [262]. His purpose was to check the respiratory, cardiovascular, and neurophysiological changes in both rat and monkey experiments, and in experiments with humans. In stressful situations the humans experienced increased gastric secretions and returned to a baseline once removed from the situation. The rat and monkey experiments brought just the opposite effect which shows the importance of the phylogenetic differential pointed out earlier.

Possibly an even more interesting study, at least from a methodological standpoint, conducted by Sandler [265] is based on an experiment conducted over a ten year period of time. An operation was performed on the subjects, isolating a fourteen inch piece of his small intestine from his digestive tract, but still connected to the original blood and nerve supply. The observations led to a direct connection between the functioning of the intestines and the emotional state of the persons.

The real importance of both the endocrine and nervous system studies lies in the direct connection between stress and physiological effects. For any model proposing stress as an etiological variable would be hopelessly inadequate without this confirmation of physiological change.

Of course there remains much to be done in the area of stress research especially in relation to disease. Is it possible, for example that some of the germs or noxious agents of disease are carried within the organism being incapable of infecting the organism until a certain depletion of the defensive hormones occurs because of a generalized adaptation to the stress? There are many other questions which could be formulated along these lines and admittedly there is much more research needed to help substantiate the relationship. But, in light of existing infor-

mation there appears to be sufficient evidence to state that stress is indeed an etiological variable.

This brings us to our next set of important questions: What is the significance of this relationship for the social scientist: How can the social scientist study the relationships involved in the relation of stress and disease? We will attempt to place some perspective on these questions in the following section.

6. GENERAL SOCIAL MODELS OF STRESS

When a behavioral scientist is confronted with a theoretical problem, such as the stress-disease relation, he will tend to interpret the possible relationships in terms of a frame of reference peculiar to his own given scientific discipline. For example, the sociologist will view the relationships not only from the perspective of the individual, but also between groups or larger social systems. One of the most popular approaches to behavior is the system-behavior theory which finds similarities among all forms of life from cells to societies, based upon analysis of all of them into "systems" composed of smaller subsystems and composing suprasystems. This systemic type of analysis can be of two kinds. The first would treat of concrete systems wherein each unit is a thing, that is, a bounded region in space and time. Many of the relationships between these things are directly observable and measurable. The second type systems theory is built around abstracted systems, that is, one in which the unit and relationships are conceptualized by a scientist to conform to his aims, frame of reference, etc. The social scientist is primarily concerned with the latter of these two kinds of systemic analysis. One of the foremost theorist in this field is Talcott Parsons, discussed earlier who has presented a conceptualization of society in terms of a set of abstracted systems. [172] Two terms are important to his conception; these are structure and process. Structure refers to the three dimensional spatial organization of the subsystems of any system at a given time. The structure of a society then, is the configuration of its component organizations, each with its characteristic activities. The term process is used to devote the dynamism or dynamic interchange in subsystems and is twofold in nature, that is, it refers either to function which is the reversible action of systems, or history, which is the irreversible action like growth.

One other very essential characteristic of the systemic form of analysis also discussed earlier is the idea of equilibrium. This idea is adapted from the principle of homeostasis in the living body. This means that the living organism, through a regulation of both inputs and outputs of energy and information, maintains the rate of functioning of its subsystems in a condition of equilibrium which, in turn, is governed through feedback processes. The society regulates its actions in much the same way, that is, by controlling the means of flow of information of its actions and behavior.

This type analysis has been helpful in the analysis of stress from two different viewpoints, the first being on systems level in the sense that societies must adapt to stresses in much the same way as do individuals. The second form of analysis is a partial derivative of the systemic analysis called role analysis which provides a base for the study of phenotypic reactions and adaptations to stress.

On the social systems level, as on the level of the individual, there can be stresses. A stress here would be understood as any force that pushes the functioning of important subsystems beyond their ability to restore equilibrium through ordinary, nonemergency adjustment processes. A stress of this nature according to Miller [266] may either consist of a lack of some essential input like food, air, or water, or an excess, in which too much heat or cold or other input floods the system ... it should be understood that stresses may be either of matter-energy or of information.

However, in relation to stress and disease, especially when we are considering stress as an etiological variable, the systemic level of analysis appears to be of limited value. Perhaps if one were to speak of "sick" societies the model could be applicable with stress being a direct causal variable. However, in an indirect sense, the systemic level can be important, in the sense that systemic stresses in the form of informational transfer which contributes more or less to the solidarity of a group or organizational subsystem could be etiological in the areas of mental health. Durkheim [244] proposes that the suicide rates, for example, vary in relation to the degree of integration into the larger social system. Also, consideration of the socioeconomic influences on mental illness, such as those considered in a study by Srole et. al, [249] can possibly be isolated on the systemic level of analysis. However, for the most part, the systemic level of analysis is too general to be of great use in the study of the relationship of stress as an etiological factor in disease, except of course in the indirect ways already noted.

Systemic analysis has been of much greater value to the social scientist in its opening of the doors of role theory. For Parsons [172], while conceptualizing society as a set of abstracted systems, pointed out that the unit of the social system is not the individual but the "role". For the individual may behave quite differently in social contexts. This system of which he speaks is a set of relationships in action and persons fit into the relationships. Likewise, a person fits positionally into a system, that is, where he is located relative to other actors. Parsons [172], calls this a persons "status". Thus, the unit of analysis for role theory is not the person, but the status-role bundle. In the present work we group persons with similar status-role bundles into phenotypes. In Parsons scheme status is the positional aspect and role is the processual aspect determining what the actor does in his relations with others.

There have been many applications of role theory in research but few in relation to stress. One of the most notable of these exceptions being by Robert L. Kahn, et al [267] who deal specifically with organizational stress. However, their model is also directly applicable to stress as an etiological variable in disease.

Kahn analyses stress in relation to two different formulations: role conflict and role ambiguity. Before presenting either, however, there are a few terms that need to be described. The first already discussed is role itself. Once again, for clarity however, role is defined by Kahn [267] as: a set of activities defined as potential behaviors. These activities constitute the role to be performed by an person who occupies that office. Other related concepts of Kahn's model are: first, role set, which is the sum total of related roles bearing on a particular role. For example, a press foremans role set might be composed of his supervisor, other office workers, his subordinates and people who are related to him in other ways like family, close friends etc. And each of these persons may potentially influence his behavior. Similarity in role sets is another way of defining phenotypes. Secondly, role expectations, which are the prescriptions and proscriptions held by members of a role set. The content of the expectations may include preferences with respect to specific acts and personal characteristics or they may deal with what the person should do, etc. Thirdly, the sent role, which is the defined expectation of behavior relative to the occupant's job. Fourthly, role pressures, these refer to the numerous acts making up the interaction that is directed toward the occupant of a role to fulfill the expectations of that role. These pressures are not merely the informational attempts of the role set but are all the prescriptive or proscriptive actions designed to elicit conformity.

Consequently, in the interaction of all these aspects of role behavior two important things may emerge. The first is role conflict; the second, role ambiguity. Both of these concepts are considered to be highly stressful. Role conflict is seen in relation to our conception of social roles which took into account the fact that various members of the role set may hold different role expectations toward the focal person (the occupant of the role). At any given time they may impose pressures on him toward different kinds of behavior. To the extent that these role pressures give rise to role forces within him, he will experience stress. As a social model for analysis of the relation between stress and disease then, the scientist would attempt to isolate the roles a person plays and to determine which of these roles by their very nature are stress producing in themselves.

The second model emerging from role theory, as we mentioned, is role ambiguity. This situation arises from an inadequate role sending, that is, a lack of agreement or coordination among the role senders produces a pattern of role expectation which contain logical incompatibilities or which takes inadequate account of the needs and abilities of the focal person. This in and of its very nature becomes highly stressful to the role incumbent and is thus seen as being a potential etiologic agent in disease.

It should be noted that both role conflict and ambiguity may be present at one and the same time and also that the amount of stress will be modified by various properties of personality. However, the social scientist, in this case the sociologist, is not so much interested in

personal adaptations, rather, his interest lies in the fact that he can objectively look at roles and isolate those which are conflicted and to a lesser degree those which are ambiguous and predict that occupants with these particular role sets are in a higher or lower stress area. In relation to diseases then, the study would focus around role incumbents of low stress role sets and role incumbents in high stress role sets and their consequent disease histories. It should be further noted that each researcher would naturally refine his own model and account for many extraneous and confounding variables, but this, is not our purpose. Rather, we are interested in briefly showing a general model relating stress as an etiological variable from the point of view of role theory.

Another possible model relating stress to disease in an etiological manner, which has stemmed from role theory, has been utilized by David Dodge [268]. The model we just presented, that is, role conflict and/or ambiguity model, had as its focal concern the processual aspect of role theory. In contrast to that model, Dodge's model is centered around the positioned aspect of role theory or status. His reasoning is that every person's life is constituted by a myriad of social roles which form a particular status set or status configuration. For example, a person may be father, husband, doctor, benefactor, president of board, etc., and the sum total of these constitute a status configuration. Each status configuration is characterized by being more or less stressful. Then in much the same manner as was seen in the processual role theory model, the researcher correlates the relationship between these hierarchically ranked indices according to the potential stress accruing to the incumbent of a given status configuration, and their disease histories. The parallels between these models, that is, role conflict and ambiguity seen from its processual and positional aspects, far out number the differences. In fact, they are common models approached from a different angle, that is, Kahn's application is designed for a micro-analytic type of analysis; while Dodge's application is designed for macro-analysis.

The final social model most clearly illustrates the multifactoral approach of stress and disease. However, it addresses itself specifically to the topic of mental illness and technically we suppose it could be objected to on the basis that mental illness isn't a disease. This model is the one employed by Srole, et. al [249] in the Midtown Manhattan Study. We have discussed the underlying conceptual framework for this type model in the section on definition of stress. It will be recalled that the model is based on the mechanical stress/strain model, in which noxious, or potentially noxious factors are called stress and the reaction is called strain. This physical analogy captures the essence of the relationship for the researchers. For they hypothesize as the number of environmental stresses increase, so also does the amount of strain, in this case, psychiatric impairment or disorder. In their conception they employ both internal environmental indicators or measures as well as external environmental indicators of stress. These indices of stress were listed as fourteen stress factors. Examples of these are:

"The first childhood factor was Parents' Poor Mental Health. It was based upon reports of the parents' psychosomatic conditions, whether they were the "worrying type", and whether they had ever had a "nervous breakdown". Parents' Poor Physical Health consisted of reports that father or mother was in poor health during the respondents childhood ...

The adult stress factors pertained to the respondent's present life experiences. First was his report of his present health status as poor rather than fair, good, or excellent, and his mentioning of a large number of nonpsychiatric hospitalizations ... Socioeconomic Worries comprised worrying about "getting ahead" and the "cost of living" ... [256].

These are just a couple of the measures used to indicate the stress load of the respondents. In turn these indicators were divided and measured in terms of such demographic variables as socioeconomic status, age, sex, occupational mobility, etc. All in all, 148 social variables are measured in relation to the symptom groups determined by the stress indices which in turn are correlated with mental illness.

In short summary, what we have attempted to show in this section on stress is that contrary to previous conceptions of disease causality employing a direct mono-causal model, more recent research in the area of stress and its relation to disease has opened a whole new area of study and a new conception of causality. For while in many cases there is a specific etiological agent, i.e., a germ, bacillus etc., the state of the organism is just as important. This has caused researchers in recent years to center on the concept of stress as a possible etiological variable and many positive results have been obtained in the areas of psychosomatic illness, diseases of adaptation, chronic diseases, and mental illness. This has in turn demanded a reorientation of thinking in our etiological model away from a mono-causal toward a multifactoral model. The consequence of the total development has seemed to involve the social scientist in the study of diseases in a new way. Previously, he was limited to studies of an epidemiological nature. However, with the introduction of stress and the consequent importance of social variables in its formation, the social scientist has been suddenly cast on to the stage of etiological research. It becomes immediately evident that because of the host of potential etiological social variables the task is not a small one. Further, it appears at this time that the area is relatively untouched.

In a benefit-cost sense it suggests a whole new series of considerations which are of critical importance to an accurate assessment of total benefit and costs. That is, what is the stress potential of this innovation? How will it differentially affect phenotypic groupings in the society? It also opens the key for considering some of the induced secondary costs and benefits that emerge as the result of the type institutional adjustments related to a particular phenomenon.

7. CONCLUDING REMARKS

The idea we have been developing to this point is that groups of people in America enjoy a different relationship with the society in terms of ability to participate in the institutions of the society. This means there is a differential availability of both goods and services depending on one's phenotypic membership. Many social scientists make this same point with respect to position in the social stratification hierarchy. In the past several pages we tried to show some of the extensions and consequences of this differential ability to participate. Those groups with a lesser ability to participate are in a very real sense marginal to the society and interestingly enough they seem to know. Early social scientists noted that the lower classes tended to perceive things as happening to them over which they have little control, while the middle and upper classes feel they can manipulate the environment. A vast body of evidence certainly supports the accuracy of the lower class perceptions. Even the choices of adaptation available to them are limited.

It has been shown quite dramatically in recent years that even the availability of health is not equally distributed in the society. As early as the 1820's Villermé [269] was able to show a relationship between social circumstances and differential mortality and morbidity. Also within the 1800's a study was published by McKeown and Brown [270] in which they state that mortality is directly related to the environment including the quality of housing, nutrition and water. Reports of a much more recent vintage also confirm the relationship between social class and both mortality and morbidity. Coombs [271], Altenderfer [272], Patno [273] and Ellis [274] all found significant relationships in their studies. Right to the present day researchers are reporting significant findings. In 1974 the Statistical Bulletin of Metropolitan Life reported, "the mortality ratios tended to be inversely related to social class. The ratios at the lowest level (Class V) were 1 1/2 to 2 times higher than that of the highest class (Class I) for all ages combined." These relationships may be even stronger when age is controlled since the factors responsible for increased mortality such as, biological and genetic factors, can be expected to influence the older groups in a similar fashion subsequently washing out the social class relationship.

There is every reason to expect, therefore, that innovations of a social, political or technical nature are going to have a differential impact on the various phenotypic groupings making up the society. As we noted earlier, assessments of impact or potential impact must be sensitive to such potential differential effects. The question, therefore, becomes; what common elements can be studied in order to provide insight into the possible benefits and costs to the groups of the society. The answer we propose is, the elements of social action and most specifically the impact on human values.

XIV. INNOVATION: A MARKETING PERSPECTIVE

1. INTRODUCTION

The basic characteristics of product life cycles have been discussed previously. Typically the sales volume of a product goes through the following six stages:

introduction	saturation
growth	decline
maturity	abandonment

Figure 28 on page 146 illustrates the sales volume and investment-profit interrelationship. A specific product life cycle of Mustang I is discussed in Appendix G. The above stages of a product life cycle are discussed in reference [275] Webster.

2. MARKETING MANAGEMENT

The duration of the life cycle can differ considerably among products, ranging from a few weeks to several decades. Fashion products may last only a few weeks whereas telephone and automobiles may have life cycles up to several decades.

Although the basic shape of the sales curve is bell shaped, it may vary among products. Important to the study of technological innovation is the fact that the duration of each stage may be different among products: in particular, some take years to pass through the introductory stage, while some are accepted in a few weeks and others fail in the introductory stage. (Stanton, [197]; Cox, [276]; Polli and Cook, [277]). Also important to the study of technological innovation is a knowledge of the marketing strategies one can employ to shorten the introductory stage, and/or extend the maturity and saturation stages.

A product life cycle depends strongly on the nature of the innovation and its process (e.g. a specific product, its R&D, production, etc). The decision to adopt a particular innovation depends on the individual decision makers and the diffusion of information about the innovation. The attitude of a particular decision maker as well as the processes of diffusion of information are, in turn, dependent on (1) opinion leaders and (2) innovators.

3. DEFINITION OF INNOVATION

Several definitions exist as to what is a new product. An innovation has been variously defined as a product that: (1) is "very different" from

established products. To be called new, says the FTC, a product must be entirely new or changed in "a functionally significant respect". (2) has been on the market for a very limited period of time. Six months is the maximum time that a product should be called new, according to the FTC'. (3) has achieved a very limited sales penetration level. (4) is new in any way for the company concerned. (5) is perceived by most consumers as "new". [278]

New products can be categorized in terms of the degree to which they are perceived as being new. There are the products that are really innovative - truly unique, products for which there is a real need, but for which there are no existing satisfactory substitutes. An example, might be the Salk vaccine for polio prevention.

Then there are those products which are quite different but replace existing goods serving existing markets. Television to a great extent replaced radio and movies. Plastics compete with wood and metal. Atomic power competes with other energy sources.

Adaptive replacements of existing products are a third type of new product. Freeze dried instant coffee replaced instant coffee which had replaced ground coffee. Annual auto model changes also fall in this category.

A fourth type of new product is an old product, the tangible and intangible attributes of which have been redefined thereby producing new benefits and satisfying needs not previously recognizable as being satisfied by that product. An excellent example is the extolling of the many uses of baking soda.

A fifth type of new product is created when a new brand is introduced, even if the product itself is not new, e.g., Olympia Typewriter creates a machine to be a direct competitor of IBM's Selectric.

A second way of categorizing new products is in terms of their effects upon established patterns of consumption. A continuous innovation has the least disrupting effect on established consumption patterns. Alteration of an existing product instead of the creation of a new product is almost always involved. Examples are fluoride toothpaste, menthol cigarettes and yearly new automobile models.

A dynamically continuous innovation has a relatively larger impact on consumption habits than a continuous innovation. This might mean a creation of a new product or a major alteration of an existing product. Electric toothbrushes, electric hair curlers and the Ford Maverick are examples.

A discontinuous innovation involves the establishment of entirely new consumption patterns associated with the creation of previously unknown products. Television, the computer, and the automobile are examples.

In both of these categorizations the key criterion as to whether a given product is new, appears to be how the intended market perceives it. If a product is perceived to be new in some way (appearance, use, performance or construction) it will be defined hereafter as in innovation. It should be noted here that an invention is the creation of something new. It is the conception of an idea. Innovation is the introduction of something new. Innovation is the process that gives an economic impact to an invention.

4. PRODUCT CHARACTERISTICS ENCOURAGING INNOVATION

The nature of the innovation is thought to ^edetermine its acceptance in terms of several important characteristics such as:

1. Relative advantage or the degree to which an innovation is superior to previous ideas.
2. Compatability, i.e., the degree to which an innovation is consistent with the value system of its adopters.
3. Divisibility, i.e., the degree to which the innovation may be tested or consumed in a limited amount by a consumer.
4. Complexity, i.e., the difficulty of understanding the product.
5. Communicability, i.e., the ability to make the product known in a prospective marketplace.

An excellent summary on studies of these kinds of factors affecting product adaption rates is given by Engel, Kollat and Blackwell [199]. In planning new products or technology factors like the above are found to be extremely important in order to promote high rates of public acceptance.

5. DIFFUSION OF INNOVATION

Two responses to innovation have been studied. People tell other people about the innovation. People adopt the innovation. The diffusion of an innovation is the movement of the innovation through space over time. An extensive bibliography in diffusion theory exists at the Diffusion Document Center, Department of Population Planning, at The University of Michigan. The bibliography indicates the involvement of many disciplines in diffusion research: physics, chemistry, medicine, pharmacology, rural and medical sociology, economics, anthropology, education, communication, marketing and consumer behavior, just to name a few.

Many of the mathematical models describing the diffusion process found in the Diffusion Document Center Bibliography came from physical and medical models. These penetration and epidemiological models portray the movement of an innovation through space and time analogous to the spread of an epidemic within a social system, conduction of heat, mixing of gases, or the spread of a drug in a respiratory system, a nervous system and/or a circulatory system. The more recent disciplines to be interested in this literature, are marketing and consumer behavior. In addition to testing and applying the diffusion models developed by other disciplines, these latter disciplines focus on (1) the characteristics of innovations that hinder and/or stimulate their adoption (2) the diffusion rate, the time it takes for the innovations to diffuse and the factors that affect the speed of the diffusion, (3) the social system in which the diffusion takes place, and (4) the adoption process.

When the cumulative percentage of adopters within a market segment/aggregate is plotted against time, the growth pattern of the cumulative diffusion curve resembles a typical S-shaped linear logistics growth curve. This curve starts at a zero percent adoption level and grows to and saturates at a 100% adoption level. This latter level is defined as the highest penetration level the innovation is likely to achieve.

6. ADOPTION PROCESS

The adoption process is defined as the decision making activity of an individual in relation to his acceptance of an innovation. This process is disaggregate. Diffusion is the aggregation of every individual's decision to adopt.

In deciding whether or not to adopt something new, a prospective user is thought to go through six separate mental stages: (1) awareness stage. The individual is exposed to the innovation, but knows very little about it. (2) interest-information stage. The prospect becomes interested enough to actively seek considerably specific information about the new concept. (3) evaluation stage. The prospect mentally measures the relative merits of the innovation. (4) trial stage. The person actually adopts the innovation on a limited basis. (5) adoption stage. The individual decides whether or not to use the innovation on a full scale basis. (6) postadoption confirmation stage. A person seeks assurance that he made the right decision.

Related to this process, studies have been conducted on: (1) Why some people adopt an innovation quickly after it is introduced, while others delay for some time before accepting the new product, while still others may never adopt it. (2) Why some new products succeed while the majority fail, including the factors that increase the likelihood of new product acceptance. (3) The unit of adoption (individual, household and/or firm). (4) The characteristics of the innovation. (5) The situation (social system) within which the process takes place.

Studies have also been conducted on sources of information used in each stage of the adoption process. One way of classifying these information sources, is to categorize them by source of control; being within a firm's control (commercial) as opposed to being outside a firm's control (noncommercial). Another is to categorize them by possibility of interaction; being personal as opposed to being impersonal. Returning to the adoption process model, it is seen that the sources of information that make an individual aware of the existence of an innovation tend to be firm controlled and impersonal. It has also been observed that potential purchasers tend to consult non-firm controlled personal sources of information as they move closer toward the purchase decision.

The "S-shaped" nature of the cumulative adoption diffusion curve can be explained by the reliance of a decision maker on non-firm controlled personal sources of information, and in particular, on information provided by the people that have already adopted the new product. It is reasoned that if every consumer came to an individualized decision, the probability of adopting in any given time period would be the same for all consumers, and then the cumulative diffusion curve would be a straight line. On the other hand, it is reasoned that if consumer adoption decisions are based on social influence and imitation, then the probability of a consumer's adoption in any one time period would be a function of the number of consumers who have already adopted the innovation. In such a case there would be a "snowball" process of rapid growth resulting in a logistic cumulative diffusion curve.

Convincing evidence for personal influence is noted in the diffusion of a new drug among physicians. Studies indicate that the socially integrated doctors adopt the new drug sooner. It has also been observed that consumer social integration relates strongly to the adoption of a new coffee product. Better integrated persons are likely to adopt these new products sooner and in greater concentrations.

Diffusion of technological innovations among firms in the bituminous coal, iron and steel, brewing, and railroad industries was studied by Mansfield [279]. S-shaped growth patterns were again obtained. Mansfield found that as the proportion of firms already using an innovation increased, the rate of adoption increased during the growth stage; that is, competitive pressures created a "bandwagon" effect.

The influence and imitation process in industrial markets, however, may differ in form from that in consumer markets. Instead of occurring as a result of verbal interaction (word-of-mouth advertising), the effect may come about as a result of the visibility of a competitors' strategies. Thus, as Webster [275] has found, word-of-mouth advertising among purchasing agents and engineers in different companies has "little significance". A significant reason for this finding is the philosophy of keeping useful information from competitors to preserve any advantage. In addition, there tends to be less interaction among industrial buyers than among ultimate consumers. Sources of influence in industrial marketing are more likely to be commercial.

7. DIFFUSION OF INFORMATION: A MARKETING PERSPECTIVE

From a marketing perspective, two diffusions (movement through space over time) exist: the diffusion of information about the existence of the innovation and the diffusion of the innovation itself. Treating a market/segment aggregate as a finite population, the diffusion of information can be described by the linear logistic curve. It is the result of the contagion process within a closed system. As an innovation is introduced, few people know of its existence. These "knowers" tell others of the product's existence. During this introductory period, due to the small number of people aware of its existence, the cumulative number of "knowers" grows slowly. In a true geometric progression the diffusion moves into a growth period marked by the first inflection point. The cumulative number of "knowers" begins to grow rapidly, as (1) the number of "knowers" in the previous time period tends to become large and (2) it is still pretty easy to find someone who hasn't learned of the product's existence. The information diffusion then moves into a maturity period which begins at the second inflection point on the diffusion curve. Here the finite nature of the market segment/aggregate begins to take effect. As it becomes harder and harder to find someone who hasn't learned of the product's existence, the diffusion curve continues to grow, but at a decreasing rate.

Finally the curve moves into a period of saturation; all that are going to learn of the existence of the innovation have learned of it. Even though one hundred percent (100%) of the market may not be reached, saturation begins at the point in time when maximum market penetration is reached.

8. RESPONSES TO TECHNOLOGICAL INNOVATION: OPINION LEADERSHIP

One response to technological innovation is to tell others about it. Opinion leaders disproportionately influence the choices of others. Opinion leadership and innovativeness are related but are treated as independent characteristics of an individual or social system. For example, some people go beyond simply communicating that the innovation exists; by influencing the behavior of others toward that innovation. As "taste makers" one method used to influence others is to try or not to try the innovation.

OPINION LEADER IDENTIFICATION

Scientists like Engel, Kollat and Blackwell [199] show that opinion leaders are not necessarily persons of high prestige in religion, government, business, education, or other spheres of activity. Rather they

tend to be persons who are product specific in their orientations though they do tend to overlap more across certain product combinations. On the basis of the research in this area Engel, et. al, concludes there is a quasi-generalized opinion leader. The nature of the interest pattern appears to be an important factor in determining the sphere of influence of these type leaders. This research also views other factors in relation to opinion leadership including demographic characteristics, social characteristics, general attitudes, personality characteristics, life style characteristics and product-related characteristics. In terms of the demographic characteristics they found that people often seek persons of like status as leaders though a significant portion look to those of higher status. Generally, the opinion leaders participate in more social activities and are more gregarious than nonopinion leaders.

In the case of attitudes the opinion leaders tend to be oriented both toward new products and products within the leaders specific sphere of influence. These leaders are usually also more innovative. Personality characteristics as measured by standard inventory instrumentation have not emerged as critical to opinion leadership. However, self-confidence is found in some instances to be important.

In a study of composite opinion leadership it has been found that variables like leadership, information exchanges, innovator, community and club involvement, independence, price consciousness, occupation, and fashion consciousness were able to explain 27 percent of the variance. While the utility of such broad based indices might be questioned they do point to the potential value of life style in opinion leadership. With respect to product-related characteristics opinion leaders were found to possess the following characteristics. They perceive themselves to be more interested in the topic area. They are more active in receiving interpersonal communications about products within their area of influence. Finally, they are found to be more exposed to additional sources of information.

9. ADVOCATES AND ADVERSARIES AS OPINION LEADERS

Opinion leadership, up to this point, has been primarily viewed as if all opinion leaders are advocates of technological innovation. Nothing could be further from reality. Opinion leaders also function as adversaries. Bright [280] has presented a very succinct listing of the reasons why technological innovations might be resisted.

1. To protect social status or prerogative.
2. To protect an existing way of life.
3. To prevent devaluation of capital invested in an existing facility, or in a supporting facility or service.

4. To prevent a reduction of livelihood because the innovation would devalue the knowledge or skill presently required.
5. To prevent the elimination of a job or profession.
6. To avoid expenditures such as the cost of replacing existing equipment, or of renovating and modifying existing systems to accommodate or to compete with the innovation.
7. Because the innovation opposes social customs, fashions and tastes, and the habits of everyday life.
8. Because the innovation conflicts with existing laws.
9. Because of rigidity inherent in large or bureaucratic organizations.
10. Because of personality, habit, fear, equilibrium between individuals or institutions, status, and similar social and psychological considerations.
11. Because of a tendency of organized groups to force conformity.
12. Because of reluctance of an individual or group to disturb the equilibrium of society or the business atmosphere.

One can generate a hypothesis as to who will be an advocate, adversary or indifferent to a particular innovation based on the degree and direction of affect of that innovation. The perception that they would be strongly positively affected by an innovation would induce opinion leaders to not only accept it (innovate) but to advocate it to others. The perception that they would be strongly negatively affected by an innovation would induce opinion leaders to not only reject it, but oppose its acceptance by others.

The perception of degree and direction of affect would be based, partially, on previous affect. If, for example, the innovation is perceived as reducing a strong negative affect that occurred because of its absence, the innovation will be perceived as strongly positive and advocated. One cruel response by an innovator, to insure adoption, would be to withhold the innovation from the marketplace, that is, until many people have been negatively affected and realize that if they had the innovation they would not have been so adversely affected.

10. A SPATIAL/TEMPORAL VIEW OF ADOPTION

An epidemiology based diffusion model may provide the foundation for the treatment of innovation adoption and its impact over space and time. The epidemiological approach permits not only a consideration of adopters and non-adopters but also the effects of a removal rate. This is an analogous situation to the differential significance various values may demonstrate if viewed at multiple time points through an event sequence. The removal rate allows for the elimination of values that may be no longer pertinent to individual behavior.

Several scientists have dealt with a time series epidemiological diffusion model. However, as Brown [281] has noted, this time series model requires modifications so as to include the spatial components. An example of such a modification is offered in the modified Keimark and McKendrick time series model by Kendall [28].

Where

$$(A) \quad \frac{dx}{dt} = -\beta xy$$

x = number of susceptibles (non-adopters)

y = number of infectives (active adopters)

$$(B) \quad \frac{dy}{dt} = \beta xy - \gamma y$$

z = number of removals (passive adopters)

dt = an increment of time

$$(C) \quad \frac{dz}{dt} = \gamma y$$

β = infection rate (adoption rate)

γ = removal rate (discontinuance rate)

The first equation (A) illustrates the adoption process with the last equation (C) defining the removal or discontinuance rate. Equation (B) represents the impact of both removal and adoption on the population of adopters.

In adapting the model to a spatial temporal format Brown [281] suggests that variables x, y, and z be treated as proportions that will reflect variability on a plane (P) through time (t). He indicates the following variables should be included:

σ = the number of persons per unit area

ds = an element of area

\bar{y}, \bar{z} = spatially weighted averages of y and z

Using Brown's [281] modifications

$$"x + y + z = 1"$$

with the differential equations becoming the following

$$A' \quad \frac{\partial x(P,t)}{\partial t} = -\beta \sigma x(P,t) \hat{y}(P,t)$$

$$B' \quad \frac{\partial y(P,t)}{\partial t} = \beta \sigma x(P,t) \hat{y}(P,t) - \gamma y(P,t)$$

$$C' \quad \frac{\partial z(P,t)}{\partial t} = \gamma y(P,t)$$

The computation of \hat{y} is provided through the utilization of the following

$$\hat{y}(P,t) = \iint \lambda(P,Q) y(Q,t) ds$$

Where:

ds = an areal element at point Q

$y(Q,t)$ = the proportion of adopters at point (Q) time (t)

$\lambda(P,Q)$ = a weighting coefficient which demonstrates the influence of an adopter at Q upon a non-adopter at P . "

The expression $\lambda(P,Q)$ provides an important spatial component to the model. It expresses the areal influence of adopters at location P on those who have not adopted at location Q . Brown notes that $\lambda(P,Q)$ represents a normalized function. He observes that the integration for the computation of $\hat{y}(P,t)$ would occur over the entire surface with a comparable procedure being utilized for the proportion of removals (z):

$$\frac{\gamma \hat{z}(P,t)}{\partial t} = \gamma \hat{y}(P,t)$$

Brown indicates that if the above is divided into equation (A') it will yield a point specific solution:

$$\frac{dx(P,t)}{dz(P,t)} = -\sigma x(P,t) \frac{\beta}{\gamma} = -\sigma x(P,t)/p$$

It follows from Brown's formulation that under the initial constraints:

$$\begin{aligned} x(P,0) &= 1 - \epsilon(P); \\ y(P,0) &= \epsilon(P) \\ z(P,0) &= 0 \end{aligned}$$

that:

$$x(P,t) = (1-\epsilon(P))e^{-\sigma z(P,t)/p}$$

Under the assumption that x, y , and z are proportions the above expression may be combine with C' to yield:

$$\frac{\partial z(P,t)}{\gamma \partial t} = \epsilon(P) + \left[(1-\epsilon(P)) \left(1 - e^{-\sigma z(P,t)/p} \right) \right] - z(P,t)$$

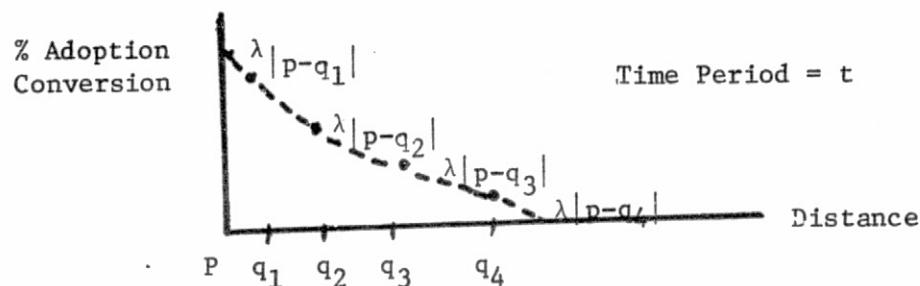
Brown suggests that the above model incorporates a distance decay effect through the normalized weight function $\lambda(P,Q)$:

$$\lambda|_{P-q_1}| > \lambda|_{P-q_2}| > \lambda|_{P-q_3}| > \dots > \lambda|_{P-q_n}| > \dots > \lambda|_{P-q}|$$

$$\text{Where } \lambda|_{P-q;}| = 0$$

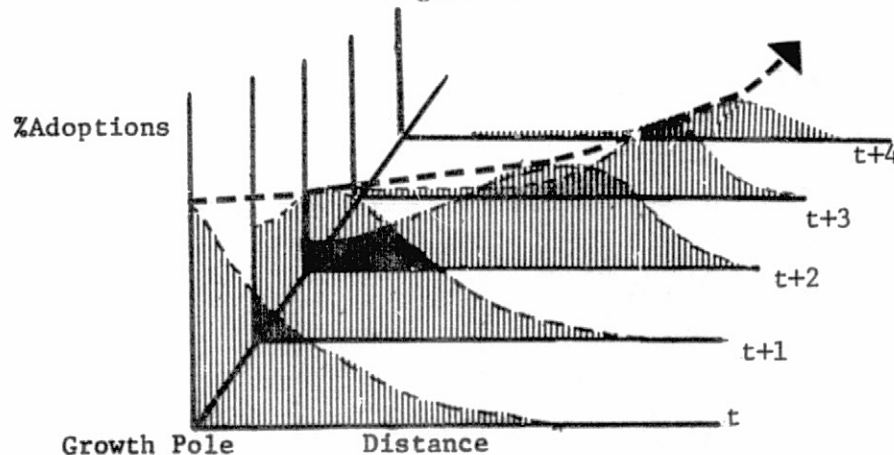
A graphic portrayal of the above would yield the following decay effect:

Figure 70.



A propagation wave may be defined for the preceding by the inclusion of a temporal axis.

Figure 71.



It may be noted that a comparable conversion function would be defined for the removal passive adopter phase. It is anticipated that a temporal lag effect would be displayed within the conversion function:

$$\text{Time } t \quad \lambda_A |p-q_1| > \lambda_A |p-q_2| > \dots > \lambda_A |p-q_n| ; \lambda_R |p-q_1| = \lambda_R |p-q_2| = \dots = \lambda_R |p-q_n|$$

$$\text{Where} \\ \lambda_R |p-q_1| = 0$$

$$\text{Time } t+1 \quad \lambda_A |p-q_1| < \lambda_A |p-q_2| < \dots < \lambda_A |p-q_n| ; \lambda_R |p-q_1| > \lambda_R |p-q_2| > \dots > \lambda_R |p-q_n|$$

$$\text{Where} \\ \lambda_R |p-q_n| = 0$$

$$\text{Time } t+n \quad \lambda_A |p-q_1| < \lambda_A |p-q_2| < \dots < \lambda_A |p-q_n| ; \lambda_R |p-q_1| > \lambda_R |p-q_2| > \dots > \lambda_R |p-q_n|$$

$$\text{Where} \\ \lambda_A |p-q_n| = \begin{matrix} \text{Adopter Conversion} \\ \text{Spatial Decoy Effect} \end{matrix}$$

$$\lambda_R |p-q_n| = \begin{matrix} \text{Removal Conversion} \\ \text{Spatial Decoy Effect} \end{matrix}$$

As the diffusion proceeds, the spatial differential in new adopters expands in the initial phases and eventually demonstrates a level of saturation. The lagged differential effect for the removal or passive adopter conversions also shows an increasing level of saturation through the temporal sequence.

It may be observed that the amplitude of the propagation wave usually decreases through the spatial/temporal sequence. Morrill's [283] explanation for this is based on two geographic factors:

"first the diffusion waves usually reach into less appropriate and responsive territories, and second, the diffusion waves usually originate from multiple origins, meet, compete, and are dampened."

This diffusion model is provided as an example of how changes in utility over space and time may be studied and evaluated. In the section immediately following we create a utility model that underlies the operationalization of the Total Assessment Profile. The utilization of this diffusion theory is tied to that utility model. Two potential applications suggest themselves as appropriate to this endeavor and provided much of the theoretical underpinnings for the development of the procedure: (1)

the perception of a natural event and its diffusion through time and space, and (2) the diffusion of a technological innovation and its relationship to human perceptions of the occurrence of a natural event. We would like to briefly elaborate on both applications.

11. THE SPATIAL/TEMPORAL DIFFUSION OF A NATURAL EVENT: THE CASE OF A HURRICANE

In this application the perception and impact of the event over space and time is analogous to an epidemiological diffusion process. In this model we would view the movement of the storm along its path as the spread of a natural event through time and space. As the storm approaches and passes it would alter the place utility assessment through the conversion of potential victims to victims. A second conversion would occur following the aftermath of the storm in which the victims re-evaluation of the utility of their location leads to an adjustment in aspirations and a resumption of normal functions. The above conversions are analogous to an epidemiological diffusion in which the initial conversion would represent the transition of susceptibles (potential victims) to infectives (victims). The latter conversion represents the transition of infectives (victims) to removals or non-transmitting infectives (past victims). The lagged differential in the two conversions would lead to both spatial and temporal variations in the transitions. These transitions would probably exhibit a wave appearance in which the initial conversion would represent a primary wave of destruction and its associated economic, social, and psychological attributes. The secondary effects and their related impacts would be defined in a wave characterized by the second conversion (active to passive infectives).

The measurement of the storms diffusion and its related impacts is defined by changes in the utility function which we discuss in great detail later on. The composition of the attribute sets that define the perception of utility by phenotypes would change with the sequence of events associated with the storm. The incremental changes in these attribute sets define the nature of the events perception to the society. The number and phenotypic mix of adopters and passive adopters in comparison to the total society isolates the aggregate short-run and long-run impacts.

12. TECHNOLOGICAL DIFFUSION: THE CASE OF AN EARLY WARNING TECHNOLOGY

An alternative use of the previously discussed model would be associated with the implications of technological diffusion. In this application active adopters (infectives) would represent those phenotypes that would be likely to accept the innovation. These phenotypes would also function as transmitters in the model. Their utilization of the innovation influences adoption patterns by those (susceptibles) who have not accepted

or encountered the technology. The second conversion would represent a transition from the stage of active adopter to passive adopter. This would represent a cessation of the innovation's promotion. The probable cause, for the above, is normally related to a general saturation of the potential market or a reduction in the applicability of the innovation. For example, improved technology or elimination of the natural threat would reduce or remove the innovations function. Based on the preceding, adopters would no longer propagate the innovation, although, they have demonstrated a commitment to its utilization.

The diffusion process over space for an innovation normally is generated from a few centers into the more peripheral areas. The diffusion itself may reflect either a hierarchical or neighborhood pattern depending on the nature of the item being adopted, the level of capitalization, and the propagator [281,284]. While the implications of this may seem somewhat obscure, the evaluation of the utility associated with adoption is defined by changes in the utility function. Positive incremental changes introduced throughout the temporal sequence of events by the majority of phenotypic groups would assure high levels of adoption. Negative incremental perception in the utility function by influential phenotypes, on the other hand, would create barriers to the diffusion process. Incorporating these conditions may necessitate modifications of the epidemiology based diffusion model and require consideration of distance biased models, a Hagerstrand interpersonal diffusion model, or a logistic's curve model [281]. The proper synthesis of diffusion models is dependent on the application and the nature of the transmission mechanism, the networks to be used for transmission, and the potential utility of the innovation.

Further discussion of these processes is dependent on a presentation of the theoretical aspects of the utility model underlying the Total Assessment Profile. Such a model permits the researcher an evaluative capability for assessing different states of technology over a chronological sequence of events.

XV. A DYNAMIC PLACE UTILITY MODEL: AN INFRA-STRUCTURE FOR TECHNOLOGY ASSESSMENT

1. INTRODUCTION

Given the complex processes we have reviewed to this point it becomes apparent that an infra-structure of a theoretical nature is essential. Thus, we propose a dynamic place utility model. The objective of this model is to define a multidimensional mechanism capable of measuring the direct economic impacts and the social psychological impacts of a change in the level of technology. Since a considerable body of methodological literature on technological impact assessment already exists we will briefly examine it in order to show what has been done in this area. This literature demonstrates that two major approaches have been used for technological impact analysis: (1) an aggregative evaluation of costs and benefits by unification of measurements, and (2) an aggregative evaluative approach to costs and benefits utilizing an accounting framework. Several methodologies are associated with each of these approaches and are briefly presented in the following sections.

2. AGGREGATIVE EVALUATION BY UNIFICATION OF MEASUREMENT

Three major approaches have been used in order to translate variables into common units.

1. Cost Benefit Analysis - In this approach cost represents the monetary value of goods and services used or the innovation compared to benefits which represent the value of favorable outcomes. Traditional cost-benefit analysis is an attractive method because it expresses the feasibility of implementation in cost terms. Problems associated with this approach focus on attempts to aggregate economic benefits and cost and the difficulties of measuring intangible concepts.
2. Transformation Functions - According to this approach outcomes measuring the level of goal achievement on different scales are transformed to an equivalent level [285, 286]. Traditional cost benefit analysis is a particular case of the use of transformation functions where inputs and outputs are expressed in terms of economic efficiency.
3. Weighted Index of Goal Achievement - This approach requires the placement of quantitative measures on objectives so that the numerical index reflects the level of achievement of various goals. A relevant index is developed for each objective. A major advantage of this approach is that it provides an aggregate statement of outcomes in a neutral fashion. It differs from the traditional cost benefit model by not translating multiple outcomes to a single objective [287,288].

3. AGGREGATIVE EVALUATION BY MEANS OF AN ACCOUNTING FRAMEWORK

An accounting type approach is structured on the development of a balance sheet or goals achievement account that expresses the impacts from implementation of new technology. Expected or anticipated outcomes are recorded for each relevant objective using a disaggregated format. Aggregation is left to the decision maker in the accounting approach to evaluation. The following represent three major methodologies associated within an accounting framework:

1. The Planning Balance Sheet - This approach records the advantages (benefits) and disadvantages (costs) accruing to various sectors of the population from implementation of various technologies. Outcomes are then aggregated and judgements are made by the decision maker [289,290].

2. Goal Achievement Accounts - This is a similar approach to the Planning Balance sheet with the exception that an emphasis is placed on the identification of objectives while costs and benefits are seen to provide positive or negative impacts on goal achievement [291]. The decision makers choice of directions is based on the weights associated with the various goals.
3. Goal Fabric Analysis - This approach utilizes the goal achievement account, however, it provides for the development of a unified scale to determine preferred alternatives [292]. Goals are structured within this approach so that interrelations are defined. The product of this analysis is a hierarchical linkage model which leads from general goals to specific goals. Hence, the output is a nested hierarchical model of objectives from which decisions may be made.

Traditional market-economic assumptions are made when value is placed on the costs and benefits derived from new projects. The value preference expressed is often artificial and fails to reflect the true preference of a society or subculture of that society. In addition, the traditional assessment models fail to introduce a spatial dimension to the attributes and costs of new technology. This lack of a theoretical structure to associate preferences over space to the impacts of events provides a serious limitation to applied research. One of the major objectives of this work is to provide a theoretical structure for defining the relationship between changes in preference structures and their spatial dynamics.

4. THEORETICAL UNDERPINNINGS

A fundamental step in technological assessment rests with the identification of pertinent goals and values. For most decisions multiple societal objectives are involved. Thus, the implications of implementing new technology are usually multifaceted with complex interactions between sets of objectives. This points to the importance of establishing the goals that a technological innovation would introduce. Several classes of propositions make up the category of values associated with technological implementation. Values, for example, may be expressed as moral statements, or as statements of preference, or of ends in the form of goals.

Reiner [293] notes that the study of values should distinguish between valuing procedures and the entity valued. In other words, the value process should be defined in respect to the substance. According to Reiner and Reiner [294] analysis of values should distinguish between:

1. The dimension of a goal or objective.
2. The level attained along that dimension. In this respect the stock of value possessed at a point in time.

3. The preferred level of goal attainment.
4. The discrimination mechanism used to select possible states.

Reiner also points out that decision makers utilize values in basically three ways: structural, programmatic, and methodological.

Structural approaches are based on the types of values held by populations. This requires identification of the subsystem and the values held by each of the subcomponents of that system. Studies dealing with the identification of structural values usually involve the following:

1. The spread and distribution in institutions and individuals of a particular value.
2. The degree or intensity of a particular value over space.
3. The institutional vs. the individuals commitment to a value.

The relationship of structural values to technological assessment rests on the foundation that successful implementation is not in conflict with the most widely held values of that society. Technology that would generate conflict would introduce stress and could be construed as a social cost.

Programmatic approaches to the study of values are associated with problems of implementation. These approaches, as noted by Reiner, are related to the means identification process and consist of two stages: (1) the specification and identification of feasible solutions, and (2) the selection of one of these solutions.

Methodological approaches are at the lowest theoretical level and relate to the measurement of values. This phase consists of identification of suitable techniques and defining the interactions that may exist between values. The nature of these interactions reflect in part the complexity of multiple objectives that would be encountered within a technology assessment profile. Value interactions related to a single goal, are suggested by Reiner, to take the following form:

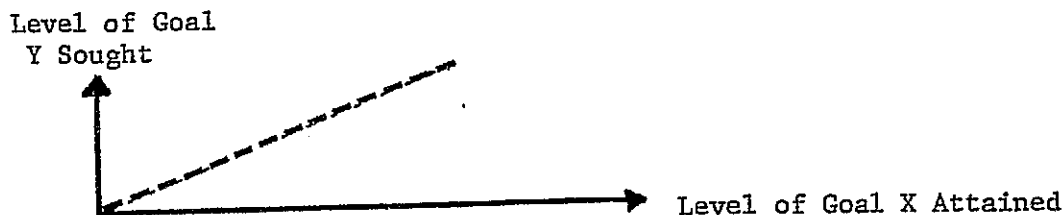


Figure 72.

The diagonal represents a set of equilibrium points or satisfaction levels. According to Reiner, for each actor, a transformation can be made from the perceived level of the valued entity to the measure of satisfaction obtained from the valued entity. In Figure 72 the internalized values are represented by the dependent variable while the external value placed on an entity is considered the independent variable. Possible forms of the interactions of the independent variable with the dependent are reflected in the following figures.

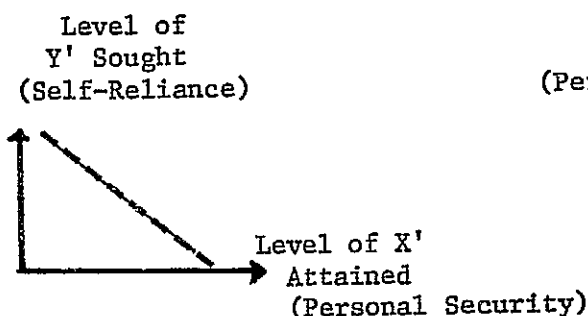


Figure 73-A.

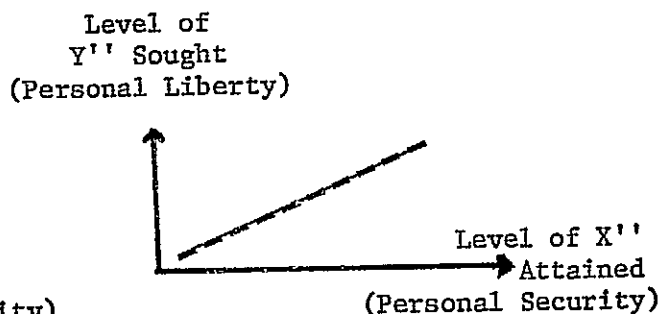


Figure 73-B.

These diagrams show that an early warning technology which is the sample problem underlying the present work may introduce several complex relationships to the existing value structure. For example in Figure 73-A improved levels of personal security resulting from the technology may reduce the level of self-reliance or individualism desired by a society. Or in Figure 73-B an improvement in greater personal security may result in a greater desire for personal liberty, such as privacy. Hence, a change in the level of an attained value may produce complex and often conflicting implications for other values held by an individual.

Externalizing values will also introduce a complex set of relationships between values. Increases in value X, for example, may increase the attained level of value Y. In other cases increasing value X may decrease the attained value of Y, or perhaps, have no effect on Y. When a positive relationship exists we have the case of "complementarity" in the value structure. For example, improved personal security would probably be complemented by an increase in economic security and well being. Reiner notes, that over time, value complementarity may take the following form:

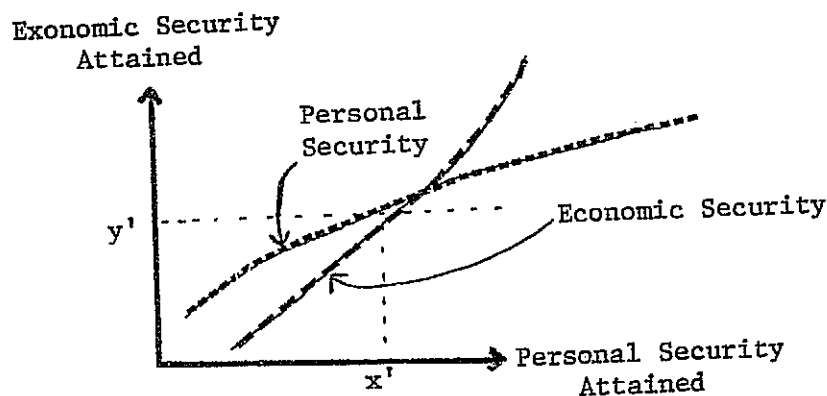


Figure 74.

In this figure a purely symmetrical relationship is not considered. In Figure 74 improvements in personal security bring about improvements in the value of economic security. At point $x'y'$ an equilibrium state is introduced.

A more complex relationship is demonstrated by Reiner when conflict is introduced through bending the iso-value curve as shown in Figure 75.

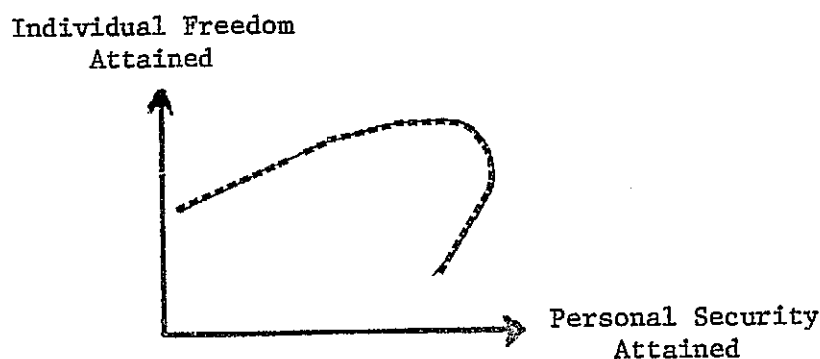


Figure 75.

This figure shows that increases in personal security will bring about higher levels of individual freedom. However, a point is finally reached in which continued increases in personal security begin to impinge on personal freedom. Hence, dependent on the particular impact an innovation will have on a value, there may be alternate levels, both positive and negative, on associated values. This discussion provides insight into the nature of the relationship between goals that may be generated from the impact of an innovation. Most projects, such as an early warning system, introduce multiple objectives for its implementation. If goals

are in harmony at least four assumptions may exist according to Reiner [293]: instrumental complementarity, goal complementarity, preeminence, and independence. The implications of each of these assumptions may be seen in the following descriptions:

1. Instrumental Harmony - This concept established the relationship between means and the attainment of several goals. Implementation of technology, for an early warning system would provide the attainment of several goals. Reiner notes that differences, in marginal benefit would be anticipated at various levels of input.
2. Goal Complementarity - This concept assumes that attainment of a goal introduces beneficial effects on the attainment of other goals. Introduction of an early warning system would go beyond the goal of just saving lives and property.
3. Preeminence - This concept is utilized as a mechanism by which conflicts between objectives are resolved. Goal preeminence established those objectives that are of the highest priority.
4. Independence - This concept assumes that goal dimensions are partially independent. This perhaps is the least feasible assumption for it forces the actor to compartmentalize goals and avoid consideration of the interactions.

Utilization of combinations of these permits the decision maker to rationally define the strategy to be employed in multiobjective models when a harmony assumption is made.

If conflict exists between plural goals four basic approaches toward resolution may be defined including imposition of a single important goal, analysis of comparative impacts, specification of weights, and constrained maximization. Briefly each of these terms mean the following [293]:

1. Imposition - This approach utilizes the preeminent objective. In other words, the goals are placed within a harmony model context by importance. The decision maker, within this context, assumes away conflicting goals or weights their importance at a zero level. In an early warning technological innovation, for example, the preservation of life and property may be placed at a level far above any conflicting goals.
2. Impact Analysis - The objective of this approach is based on an input-output model in which outputs are specified for alternative and conflicting goals. Inputs are then accessed on the basis of their availability and value.

3. Weighting - This approach resolves the problem of plural goals by defining the relative importance of various factors which may determine an appropriate course of action. Weights are mapped, according to this approach, as a payoff function.
4. Constrained Optimization - This approach requires construction of an objective function. The approach employs a linear programming model in which a set of constraints are defined. The model then becomes a guide where weighted goals are defined by an optimization procedure.

5. THE UTILITY FUNCTION EMPLOYED IN THE TOTAL ASSESSMENT PROFILE

It is proposed that the evaluation of multidimensional technological impacts be defined through the generation of an aggregate place utility model. The above model extends the traditional cost benefit approaches by incorporating socio-psychological dimensions and their potential impacts on the preference structure of aggregate phenotypic groups within the society. In addition, the model's infrastructure is dynamic in character and permits a comparison of changes in phenotypic preference structures through time and space.

Based on a spatial temporal continuum a generalized environment that would represent normal levels of interaction in a steady state may be defined for each phenotypic group [295]. The above concept is based on an earlier paper that demonstrates the relationships between community, organizational, adaptations, and individual event sequences through time and space. The generalized state of perceived event sequences or attributes of a location for each phenotypic group are defined for a point in time. The societal perception of the attributes associated with the sequence state would be represented as the aggregate of the phenotypic perceptions. The following provides the aggregate utility equation:

$$U_A = F[W_I U_I(S_{x_i t_o}) \dots W_N U_N(S_{x_i t_o})]$$

Where:

U_A = Aggregate Place Utility for a Community

W_I = Phenotypic Group Weight ($W_I = P_I/P$ where P_I equals the population of phenotypic group I and represents the total population)

U_I = Utility Level for Phenotype Group I

S = Socio-economic-psychological Scaled Attributes for each value to be selected such as security, health, etc.

x_i = Location i

t_0 = Time Period

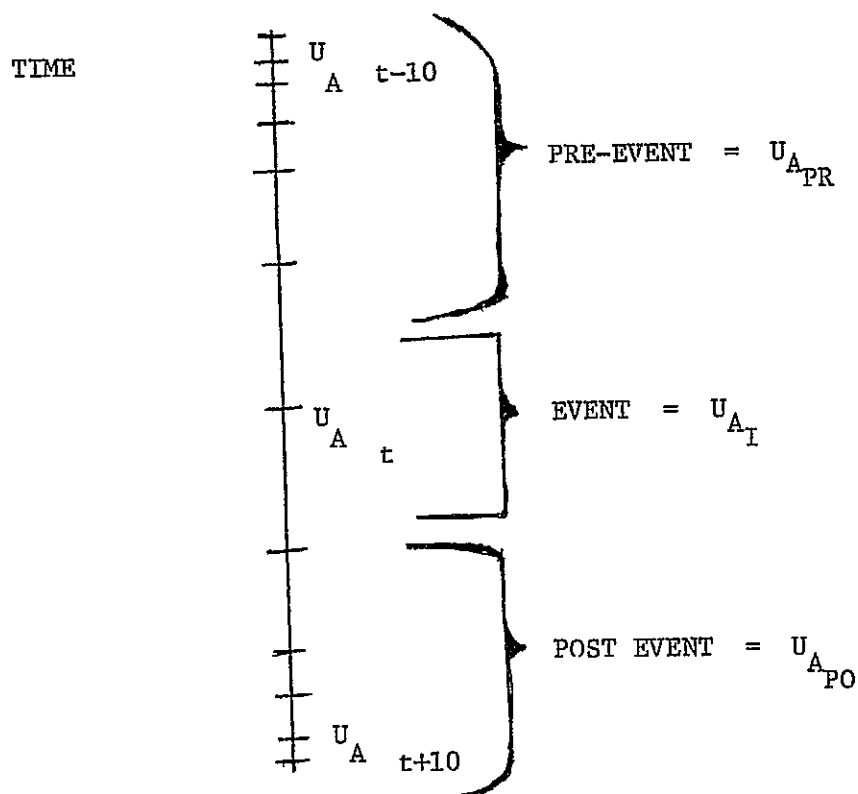
It may be noted that the primary components of the proposed place utility function consist of the following:

1. A multidimensional model having several subsets. The sets are identified in the formulation of a preference structure based on Maslow's hierarchy of needs.
2. The model represents an aggregate utility function generated from perceived group preferences, rather than an individual utility function. Hence, we are able to incorporate phenotypic perception patterns and avoid the problem of predicting individual behavior. The major criticisms of traditional utility theory rest on its weak performance in the prediction of individual choice behavior. The more generalized phenotypic preference structure should demonstrate greater overall predictability compared to an approach dependent entirely on individual action [296].
3. The model is predictive rather than normative in structure. Fishburn [297] notes that the predictive approach is interested in the actual choice behavior of individuals compared to a prescriptive approach which is oriented to optimal choice behavior. Recent work in perception of individual choices and the resulting actions suggests that the predictive approach may be the more realistic. The concept of bounded rationality suggests that decisions are made within the confines of man's behavioral environment (the perceived environment) rather than an objective environment. It should be noted that a substantial difference may occur between the perceived and objective environment. Hence, purposeful and satisfying behavior may be demonstrated by individuals which when compared to the objective environment would represent irrational decision making [297].
4. The model is additive in character and may aggregate the individual phenotypic scaled attributes to a general utility level for the total community. It may be noted that the aggregate utility level is defined as a function of the individual phenotypic utility values [292]. The nature of the functional relationship is problem oriented and in some cases may represent a simple linear re-

The derivation of the aggregate utility value is generated from the individual phenotypes. Each major phenotypic group will perceive an event or sequence of events from different perspectives. Hence, each phenotypic group will demonstrate a different preference structure:

It should be noted that the above attribute sets are to be established empirically through the use of a multidimensional scaling procedure. The composition of these sets would change with the nature of the problem or application. This may also be true in relation to the phenotypic structure which would be empirically defined and may vary with geographic location.

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Where

- $U_{A_{PR}}$ = represents the pre-disaster utility level
- U_{A_I} = represents the impact disaster utility level
- $U_{A_{PO}}$ = represents the post disaster utility level

The above event sequences are generalized and would represent an application in which an inventory of utility levels could be defined prior to an event, at the time of the event, and in the post event period. The above methodological design may be appropriate for the study of areas that are subjected to natural hazards such as storms and flooding. The pre-event period would represent the time prior to the occurrence of the disaster; with the event stage characterizing the period of direct impact from the disaster agent; and the post event stage being illustrative of the recovery phases. Considerable shifts in the composition of values, norms and mobilization behavior may be anticipated through the event sequence [299,284]. These changes will be demonstrated in the spatial utility function.

The preceding sequence of utility values represent the stages in the occurrence of an event while the level of technology remains fixed. If the event were to reoccur it would be anticipated that each iteration

through the sequence would generate improved technological coping mechanisms and would stimulate modifications in individual and group behavior (learning). Hence, for a fixed level of technology and a specific position on the learning curve, comparisons of the total utility value for a location through a disaster sequence would define the relative costs and benefits of the event. It would also indicate the perceived value of a particular technological state in coping with the event and its aftermath. Through the temporal dimension, the inclusion of both immediate impacts on values (in the event stage) and the longer run secondary impacts on values and norms (in the post event phases) may be defined.

The assessment of the event's perceived impact and the technology's perceived coping capabilities may be determined by a simple ordinal comparison of the total utility level between the time periods:

$$U_{A_{PR}} > U_{A_I} \quad \text{THE EVENT IS PERCEIVED NEGATIVELY}$$

$$U_{A_{PR}} = U_{A_I} \quad \text{NO IMPACT IS DEMONSTRATED}$$

$$U_{A_{PR}} < U_{A_I} \quad \text{IMPACT IS POSITIVELY PERCEIVED}$$

The inequalities represent comparative differences in the magnitude or order of the aggregate utility levels. In the first case we find that the pre-event utility level is higher than the event utility level. The preceding implies that the aggregate effect of the event is negative. It may be noted that individual phenotypic groups may perceive the event as having differential utility. For example, a rain storm may be perceived negatively by urban residents while rural residents may perceive it in a positive frame. When utility levels are equal we would anticipate either indifference or lack of detection of the event by the population at large. If the event increases utility, as in the third case, the event is perceived in a positive manner. The effectiveness of the recovery effort would be reflected in the relationship of the post disaster utility level to the pre-disaster aggregate utility level:

$$U_{A_{PO}} > U_{A_{PR}} \quad \text{The recovery effort has increased utility}$$

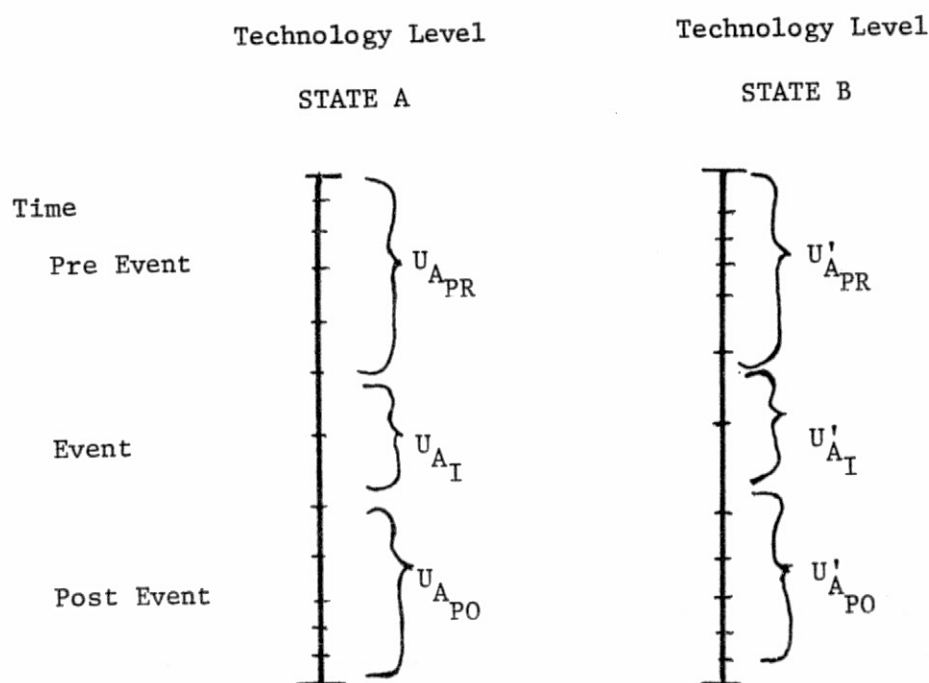
$$U_{A_{PO}} = U_{A_{PR}} \quad \text{The recovery effort has reestablished the pre-disaster level}$$

$$U_{A_{PO}} < U_{A_{PR}} \quad \text{A lower utility level is introduced following the disaster recovery}$$

It is important to note that in the above situation a spatial differential may be exhibited. For example, if the disaster impact zone is located in a central city area that has been evacuated prior to a serious storm the post aggregate utility level may be greater than the pre-disaster utility

level. In the above case the storm may function as an agent of urban renewal and force a concerted housing and social reform recovery effort that leaves the area better off in the post impact phase. On the other hand, a location in the fringe impact zone may experience a post utility level that is lower than the pre utility level. For example, substantial ecological damage (trees, shrubs, landscaping, etc.) may have occurred without a sufficiently critical threshold level being attained to permit large scale subsidized recovery efforts.

The introduction and effectiveness of new innovations must be evaluated within the framework of its impact on the aggregate utility function. Employing the above, requires that the potential change in the utility level be predicted from the implications that the technology would have on the attributes of place.



Where:

$U_{A_{PR}}$ = represents the pre-technology (State A) utility level

$U'_{A_{PR}}$ = represents the predicted post-technology (State B) utility level

It may be noted that multiple objectives or goals can be associated with the introduction of new technology. Through the interplay of these goals higher or lower aggregate utility levels may be established. By means of scaling the components of a society's preference structure the value added from technological innovation may be predicted. Comparisons of the

pre-technology utility levels against the predicted post technology utility levels would establish the value added from the innovation. The value added dimension would change both through time and space. Perhaps in the pre-disaster phase, the value added to the utility function may be negative for location X_i :

$$U_{A_{PR}} > U'_{A_{PR}}$$

If the event does not occur the innovation would probably represent a cost to the society and, hence, only a minimal payoff would be generated. However, if the event does occur we would anticipate that the new technology would function effectively and generate a positive payoff:

$$U_{A_I} < U'_{A_I}$$

This is meant to show that through time the utility of the innovation is likely to change. It should be emphasized that a similar condition would exist for the spatial dimension. In areas that would normally experience the event the utility value added from the innovation would probably be high compared to areas that never experience the event. A basic typology with expected value added implications that incorporate both the temporal and spatial dimension are provided below:

TABLE 9

	Technology Level STATE A	Probable Relationships	Technology Level STATE B
--	-----------------------------	---------------------------	-----------------------------

Pre-Event	Impact Area	$U_{A_{PR}}$	\leq	$U'_{A_{PR}}$
	Non-Impact Area	$U_{A_{PR}}$	\geq	$U'_{A_{PR}}$
Event	Impact Area	U_{A_I}	$<$	U'_{A_I}
	Non-Impact Area	U_{A_I}	\geq	U'_{A_I}
Post-Event	Impact Area	$U_{A_{PO}}$	\leq	$U'_{A_{PO}}$
	Non-Impact Area	$U_{A_{PO}}$	\geq	$U'_{A_{PO}}$

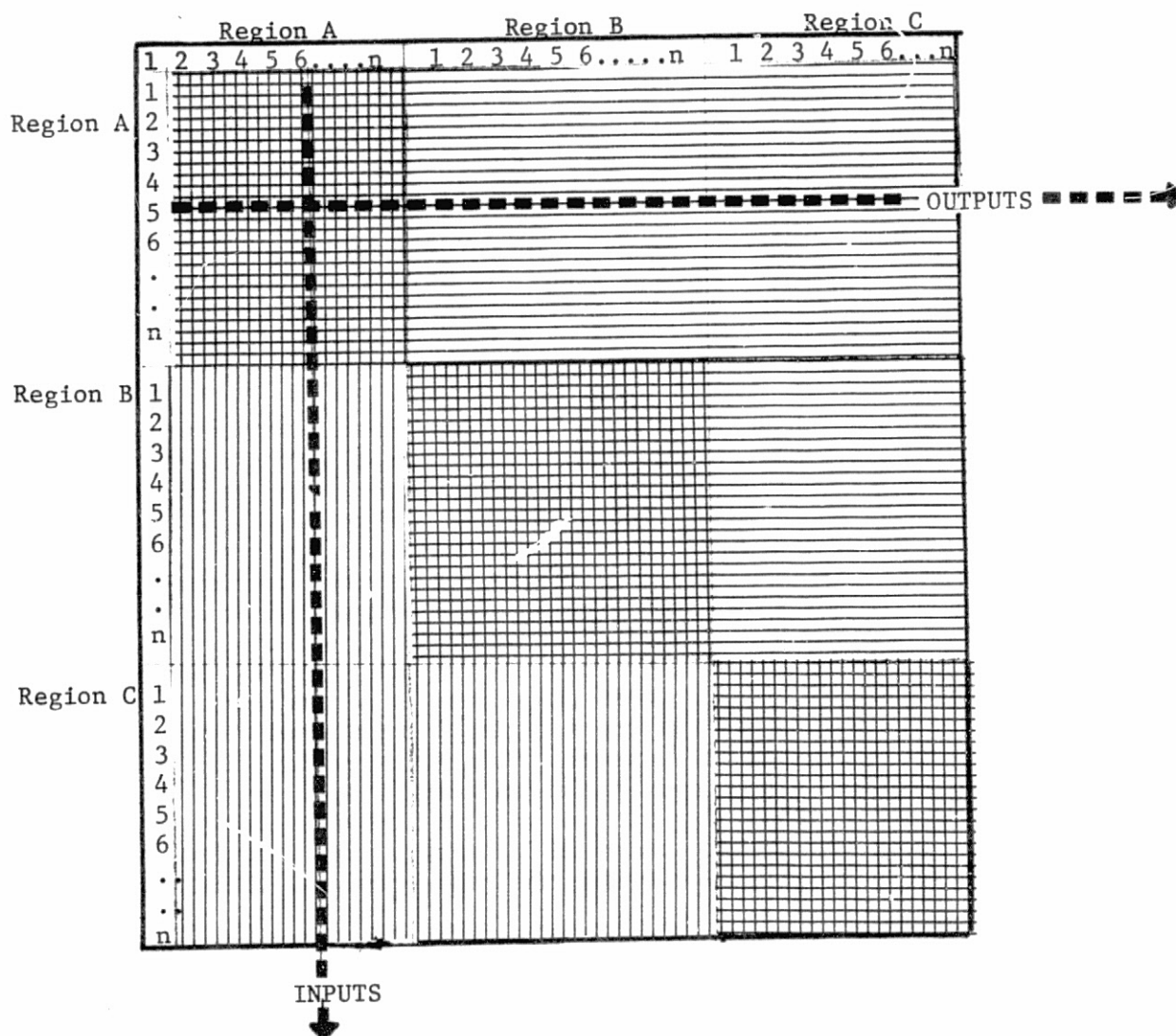
In the preceding table several comparisons are made with the probable relationship that would be exhibited defined in the center column. The table indicates that differential impacts would be exhibited between risk and nonrisk areas. These inequalities when aggregated in time and space would represent the overall value of the new technology. If the risk areas are limited in population and geographic extent, the advantage of the innovation to the total population may be very low and function as a determinant of whether government is willing to subsidize those individuals located in a potential risk area. A serious consideration in the above problem is associated with the definition of risk areas versus nonrisk regions. The above definitional problem is primarily associated with the concept of hazard perception and the construct of a hazard threshold [300]. Phenotypic variability in the perception of natural hazards and the associated behavioral response are central issues in several contemporary research problems. Based on the current research direction, the delineation of the risk areas would be defined in T.A.P. through a stochastic based regionalization methodology [284].

In addition to the above, the functional interrelationships between risk and nonrisk areas should be defined. Once the functional structure (socio-economic-political interactions) between risk areas and nonrisk areas are known the cross-regional benefits and costs may be generated. The present model does not consider cross-regional impacts. The utilization of a regional input-output model to define the functional relationships and their probable secondary impacts is suggested as a mechanism for the treatment and inclusion of cross-regional effects. The following diagram illustrates the interactions through a spatial system with the internal transactions between the economic sectors demonstrated in the diagonal elements and the cross-regional inputs and outputs illustrated in the off-diagonal elements. This illustration, is in part, dependent on the problem or application in which T.A.P. is to be employed. The present application, for reasons of simplicity and basic development concentrates on the utility associated directly with each impact region and will ignore at the present time the cross-regional utilities.

It should also be noted that several of such utility comparisons may not be suitable for other types of applications of T.A.P. In some cases a pre or a post event continuum would not be feasible and comparisons would be more limited. The current example fits the notion of a pre-event, and post event evaluation format.

A major objective of the utility analysis is the evaluation that a change in the level of technology would introduce to the group utility levels. Thus, at technology level state A, a utility level may be defined for the pre-event period. A change in the technology level to state B would result in a change in the aggregate utility values for this time period. These incremental changes in the utility level from the pre and post technology periods will yield a differential utility change in both the risk and nonrisk areas. The change or difference in utility brought about by the new technology represents a residual utility increment (value added).

Figure 76.



Risk Area Residual Utility

$$\Delta U_{A_{PR}} = U'_{A_{PR}} - U_{A_{PR}}$$

$$\Delta U_{A_I} = U'_{A_I} - U_{A_I}$$

$$\Delta U_{A_{PO}} = U'_{A_{PO}} - U_{A_{PO}}$$

Total Residual Utility (Value Added) Risk Area:

$$U_{Tr} = f(\Delta U_{A_{PR}}, \Delta U_{A_I}, \Delta U_{A_{PO}})$$

Non-Risk Area Residual Utility

$$U_{A_{PR}} = U'_{A_{PR}} - U_{A_{PR}}$$

$$U_{A_I} = U'_{A_I} - U_{A_I}$$

$$U_{A_{PO}} = U'_{A_{PO}} - U_{A_{PO}}$$

Total Residual Utility (Value Added) Non-Risk Area:

$$U_{T_{nr}} = f(U_{A_{PR}}, U_{A_I}, U_{A_{PO}})$$

The added value or residual utility concept may indicate variability through the time continuum. It is very likely that the pre-event utility level would be approximately equal at both levels of technology. The effect of the new technology would probably not become apparent until the event or post event periods. The objective for the introduction of new technology may be dependent on an objective function which would maximize, in a positive direction, the value added of new technology for most phenotypic groups. The preceding objective does not necessarily represent the highest normative level attainable but, rather represents a level that is perceived sufficiently high to offset the costs of the innovation.

A major weakness in the above approach to utility maximization rests on the static spatial assumptions. The preceding demonstrates a change in the utility function at only one location (location x_i). In reality the spread of the innovation over space would result in changing utility levels by regions, as well as, by groups within the regions. In order to incorporate a dynamic spatial dimension to the utility analysis a spatial diffusion process should be considered.

XVI. OPERATIONALIZING THE TOTAL ASSESSMENT PROFILE

1. INTRODUCTION

The utility model combined with the basic concepts of the theory of social action provide the infrastructure for the operationalization of the Total Assessment Profile. The specific contributions derived from the synthesis of the preceding are defined in the following:

1. The utility model creates the underlying structure from which technological impacts may be evaluated in a temporal/spatial format. It provides a methodological configuration for the comparison of technological states, temporal variations through event sequences, and differential impacts for target populations. This is accomplished through the utilization of the concept of place

utility. Changes in the utility function over time and space permits comparison of altered technological states, as well as, derivation of the perceived impacts of these changes on the society. It is through this comparative capability that phenotypic variability and residual utility increments (value added) may be defined.

2. The theory of social action introduces the concept of differential accessibility to societal resources: Consequently, it gives the rationale supporting dissegregation of the society into phenotypic groups. The inclusion of social-psychological phenotypes addresses the problems of decision making and program evaluation in a ranked and stratified society.

The theory of social action also establishes the organizational base for the analysis of the social system. In other words, the theory defines the primary components that function within the social system. In this sense, the social action theory augments the utility model by providing an explanation for the valuation of events within the context of a social-psychological behavioral base.

Combining the utility model with the theory of social action introduces a theoretical framework from which the Total Assessment Profile may be derived. Unlike earlier technological assessment models, the Total Assessment Profile is generated from the fundamental components of social theory.

The Total Assessment Profile is a systematic mechanism which extracts the impacts that a change in technology would exert on the social system as a whole and on its parts. It was noted in previous sections of this study that the impact on a societal system could be assessed at several levels: values, norms, mobilization into organized roles, and at the level of situational facilities [171]. An innovation's impact at the values level implies a subsequent effect at lower levels. It should be emphasized, however, that a change at a lower level does not necessarily affect the higher levels. For example, a major structural change in values (standards of desirability) would initiate changes in norms, institutions, and the system of resource allocations. A current example of this is seen in the intense desire for national energy independence. The expression of this desire or value is demonstrated in the striking changes which have been introduced at the lower level components of the social system. Both the public and private sectors have been forced to re-orient their behavior to facilitate the attainment of this new value. Unfortunately, the ramifications of these changes have had a differential impact on various members or phenotypes within the society. The poor, in part, due to their limited political influence, have been forced to absorb a disproportionately larger share of the sacrifices associated with situational facility and role mobilization changes.

Because of the nesting effect, the Total Assessment Profile must operate at the highest and most general level of the social system. This necessitates that T.A.P. be an evaluative instrument with its primary focus being directed to the value structure of the society and to its member groups. An impact on the values of the society would be differentially exhibited at all lower levels.

A similar nested hierarchical effect would be demonstrated within each level of the social system's components. Smelser suggests that seven specific levels may be employed in the assessment of social action components. Within his hierarchy there is a diffusion from the most general level to the least general level. A similar hierarchy may be observed in Maslow's five levels of needs discussed earlier. This hierarchy demonstrates a progression from the highest and most general level needs to specific self-oriented needs [243]:

Level

1. Physiological Needs or Values
2. Safety Needs or Values
3. Belongingness and Love Needs or Values
4. Esteem Needs or Values
5. Self-actualization Needs or Values

In Maslow's system the axiomatic values represent the highest levels. Nested within the axiomatic concepts at lower stages in the hierarchy are values of a less critical rank to life. If the axiomatic values are not attainable, the significance of the lower self-actualization values are meaningless. In other words, the value of survival surpasses the values associated with the pursuit of education, art, etc. Without the ability to survive, it is obvious that these lower values have little meaning. Thus, a technological impact on a major societal value will not only affect the value directly, but will also impact on lower nested values. In addition, the impacts on the value structure will have ramifications on society's norms, institutions, and resources.

In conclusion, a meaningful assessment of technology must include an evaluation of the technology's impact on the elements of the social system. The Total Assessment Profile, therefore, will utilize the highest indicators of societal structure by employing value structures and changes in value structures as the determinant for measuring technological impact.

2. THE OPERATIONAL FORMAT FOR T.A.P.

The direct effects of a technological impact may be assessed through the derivation of a comparative values impact matrix for each major phenotypic group. The general structure of the matrix is based on a hierarchically defined value set employing Maslow's [243] needs classification

categories. The values included in the matrix are a representative sample of the values found in Maslow's scale for each of the five levels. Appendix J is an extensive listing of potential values that may be impacted upon.

The comparative values impact matrix is symmetrical having the dimensions n by n . The columns and rows of the table are rankings of the value arrays. The rankings applied to the matrix rows represent the sponsor's perception of the technology's impact on societal values. The columns of the matrix provide the phenotypic value profiles from which the technologies impact on the value structure are defined. Therefore, the elements of the matrix indicate a comparison of the value rankings and their resulting differences. The matrix facilitates the identification of perceptual preference variations between technological sponsors and their prospective consumers.

Figure 77 illustrates the general structure of the Comparative Cross Values Matrix. It may be observed that the elements of the matrix are divided into three major parts; a hierarchical value rank, a phenotypic value rank (importance scale), and a sponsor's value ranking. Each of these aspects are discussed in detail in the following paragraphs. However, it should be noted that the difference between the phenotypic value rank and the sponsor's evaluation of the technology's impact on those values appears in the lower-right corner of the individual matrix cells. The degree of similarity or dissimilarity in the differences is construed as a measure of the technology's perceived benefits and costs. Stresses and benefits are defined by the positive or negative sign of the impact appearing in the lower right cell position and the size of the number.

There are two separate scaling problems associated with the data matrix. The first of these is concerned with dimensioning the phenotype and sponsors values. Once the values are selected for inclusion in the assessment they are formulated into a series of paired comparisons. The paired comparisons technique becomes part of the survey research instrument that is administered to the social areal phenotypes. Examination of Figure 77 helps to illustrate the outcomes of the scaling procedure. In the top horizontal rows the cells are assigned a hierarchical value rank. This value is used for weighing the impacts on the various levels of value. The basis for this weighing procedure is found in Maslow's hierarchy of needs discussed earlier. The major reason for the weight is to control for impacts that have important consequences for dissolution or decay in the social system (a process similar to entropy in a closed system). Hence, as a value is selected for inclusion in the matrix it is first considered in terms of the "needs level" with which it is associated. In the example, the weights stem from 1 through 5 with the heavier weight assigned the most common and a basic survival value and the lightest weight assigned to the less common (more individualized) self-actualization values.

We feel it is important to note that during the course of the study a scaling procedure was considered for determining the weights of these values. However, since the basis for such scaling would be survey research and reflect a composite ranking of the population, the procedure

COMPARATIVE CROSS VALUES MATRIX:

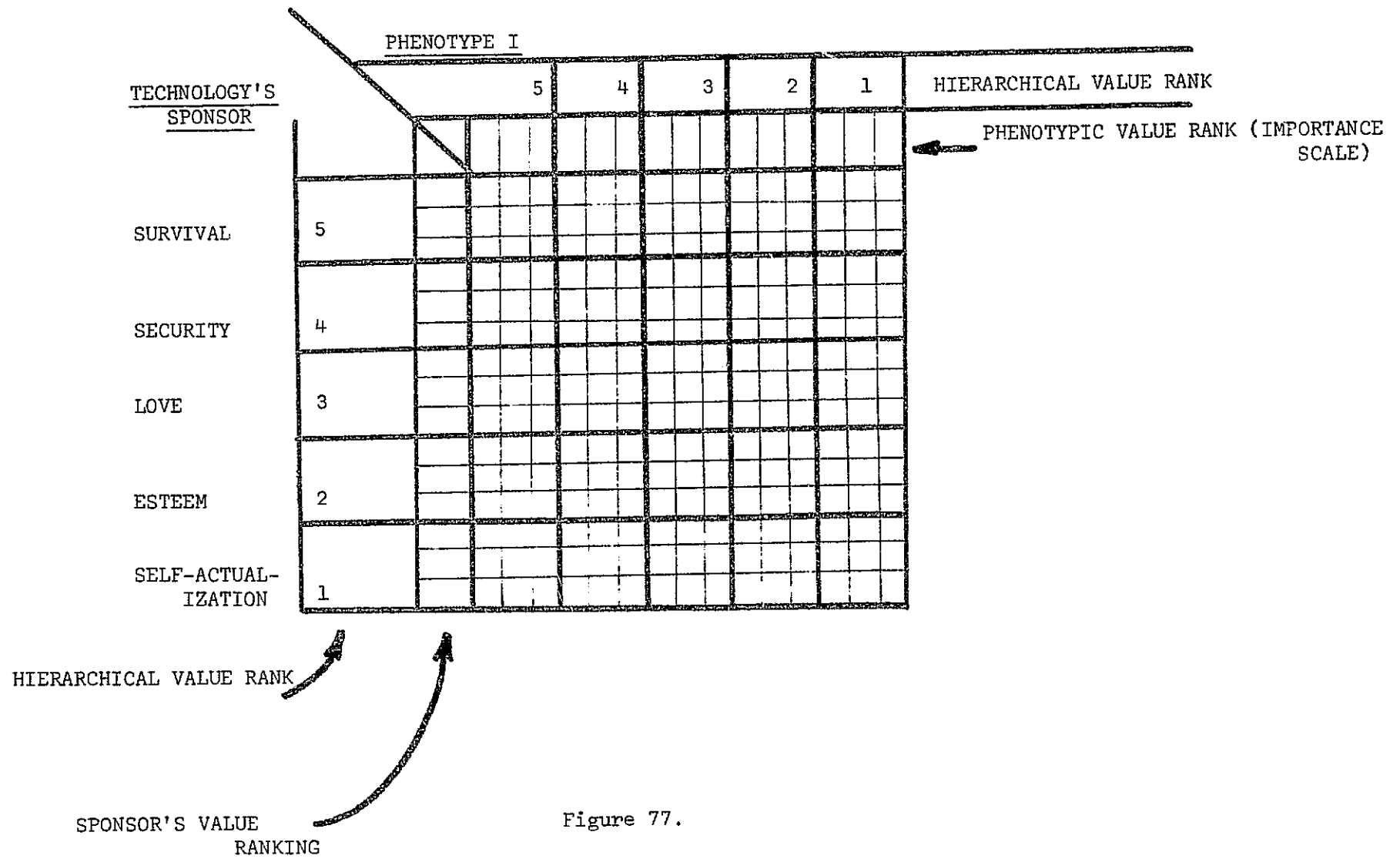


Figure 77.

becomes useless as a control. That is, the hierarchical weighing procedure is included in order to prevent optimizing on a more esoteric value while impacting on a survival value. Depending on one's position in the class structure and the values held, it is quite possible to optimize on values designed to increase one's ability to command resources and consume while destroying the ecological balance and all men's chances to survive. Therefore, these weights are designed to protect all people and the social system from being forced into a process of decay by a few who control resources and espouse a different self-centered value system.

These other values are, of course, one of the critical steps in the Comparative Cross Values Matrix and are accounted for in the area labeled "phenotypic value rank" and "sponsor's value ranking". It is at this point that the paired comparison methodology becomes important since it provides the relative perceptual weight of the phenotype for a given value. In Figure 78 a single cell of the Comparative Cross Values Matrix is presented. In the example the value is considered extremely important to the phenotype being examined and a weight of 3 is assigned this response. This weight is in turn multiplied by the hierarchical weight to produce the "rank x value level" appearing in the diagonal (+15). This is interpreted as meaning that the phenotype in question considers the value to be extremely important and in light of the needs hierarchy it is a survival value.

The second part of the example deals with the sponsor's evaluation of the impact of the technology on the same value. We stress at this point the fact that the sponsor possessing detailed knowledge of the technology is evaluating the impact of the technology in light of both this knowledge and his perception as to how it impacts. Hence, his rankings stem from ++ having a weight of +3 through zero (no impact) to a -- (an extremely negative impact) having a weight of -3. The same weighing and multiplication process is accomplished in the example and the result is a -15 in the diagonal. These weights are subsequently multiplied in order to determine the value impact product. In the cell example this figure is -225 which means the technology impacts in a highly negative fashion for this phenotype. We could add here that this is only one particular way of rating values. In our case, weights could be chosen for the Maslow's levels, for example, as 1.1, 1.2, 1.3, 1.4, 1.5 instead of 1, 2, 3, 4, 5, respectively, etc. if the large numbers like the -225 here are "objectionable" to a "sponsor". We feel this multiplicative system is very appropriate as it has the proper algebraic properties.

The second of the scaling problems mentioned earlier, deals with the identification of the underlying value dimensions to be included. We propose the use of multiple dimension scaling for this purpose. This can be done by identifying a heterogeneous but small population of informed individuals. These would include "influentials"--those whose particular interest is known to be positive and those whose views will be negative; those who are likely to benefit most and those who might prosper least. It includes those governmental officials who are responsible for development or regulation of the technology. In the case of a natural disaster

A CELL IN THE COMPARATIVE CROSS VALUES MATRIX:

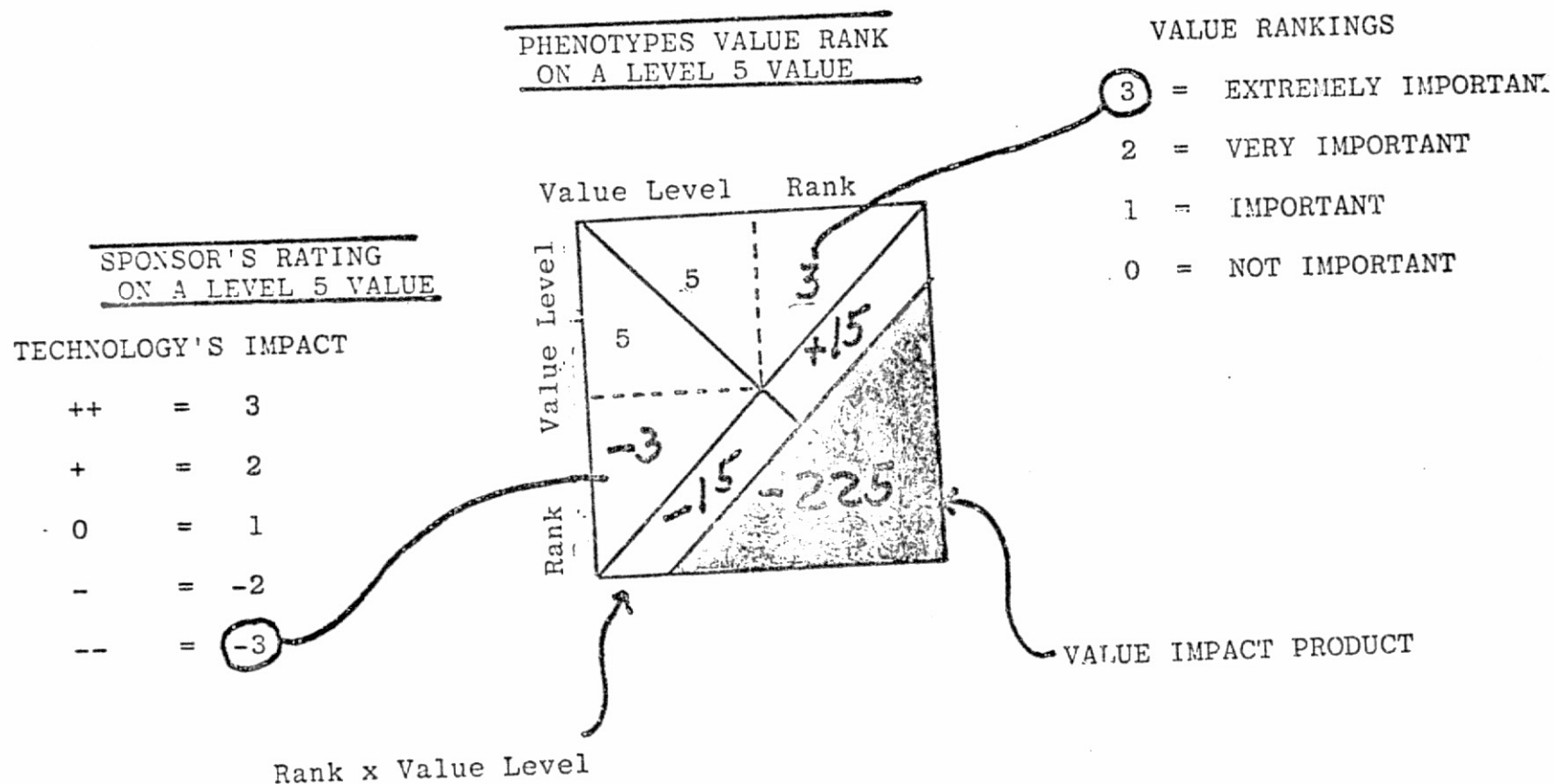


Figure 78.

warning satellite, for example, this must necessarily include persons from NASA, NWS, USAF inter alia. Clearly, the identification of perhaps thirty individuals who are sensitive to the likely areas of benefit/cost evaluation is crucial to the whole analysis. It is not important that they be "representative" of public opinion; indeed, that is not the goal. What is important is that they be inclusive of the diversity of views toward the policy or innovation under scrutiny.

The survey instrument will be based upon information gleaned from these preliminary respondents in techniques characterized by Dexter as elite and specialized interviewing. While other modes undoubtedly will be devised, these are likely to be (a) open-ended interviews or discussions of perhaps one-half hour in length; (b) a completion-type of questionnaire in which the respondent is asked to list the three, five, or whatever number of issues there are in the proposed technological innovation that concern him most. (He may be asked also to rank these issues by their importance as perceived by him.) Finally, at the end of the interview, the respondent may be asked (c) to check or to rank order a list of issues (paired comparisons, etc.) that already has been prepared.

MDS then is used to identify the underlying dimensions of similarity in the interview segment, with the insights gleaned from the open-ended discussions being used to double-check that all important values associated with the technology at issue have been included in the analysis. It becomes a relatively straightforward matter to develop a respondent-by-issue matrix, to compute coefficients of association among the issues mentioned, to cluster them in n-dimensional space, and to interpret the number of dimensions and their substantive nature. It may be that relatively few dimensions will be uncovered--perhaps three to six--despite the heterogeneity of the respondents. What is likely to be observed is that, despite their heterogeneity the number of dimensions uncovered will not be great. Instead, it is likely that a wide range of scores on each of the several substantive dimensions will be observed. With this information about the number and type of dimensionalities likely to be present in the data, and with the information about phenotypic behavior, it is possible for the investigative team to follow the principles of survey methodology in obtaining the proper value rankings from the phenotypic groups.

The Total Assessment Model is not normative in structure, it is a behaviorally based model. The rationale underlying the choice of the model has been documented in previous sections of the study. The emphasis is placed on the perception of the behavioral environment or symbolic universe of the sponsor versus the phenotype. Stresses and benefits are seen as negative or positive departures in the perception of the technology's impact on the value or preference structures. Since the objective is the measurement of the impact on values, T.A.P. contains within it the indirect affects on societal norms, institutions, and resources. These stresses and benefits would exert an influence on the components of the social system for a point in time and for a location.

Figure 79 represents an expansion of the preceding in order to demonstrate phenotypic variability. Each matrix is constructed in the same format with the sponsor's perceptions being held constant. The column rankings, on the other hand, vary with each phenotype. The differences in cell perceptions, as expressed by traverses through the matrices, provide a profile of the technology's impact across the societal value structure.

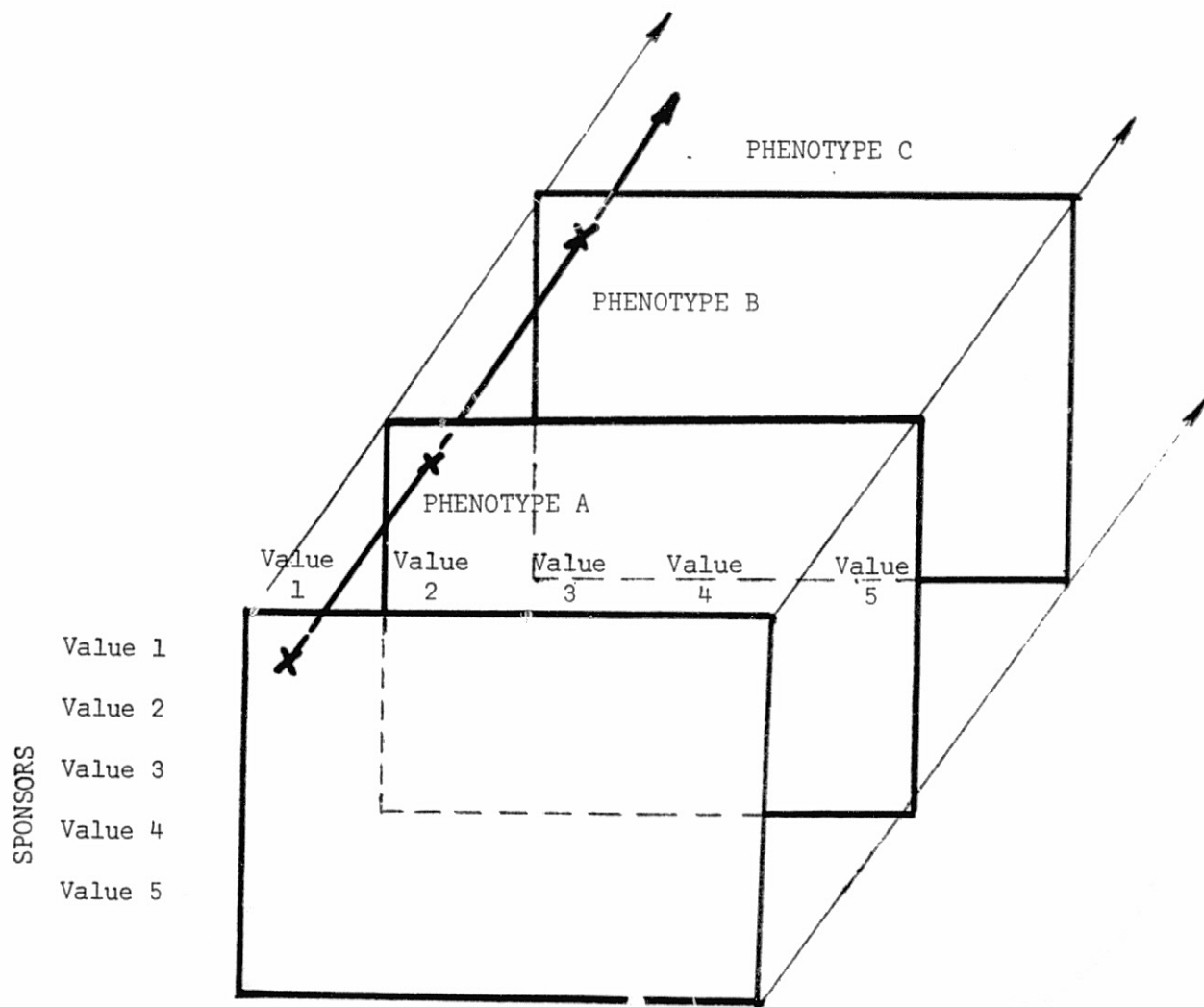


Figure 79. Comparative Values Impact Matrix By Phenotypes

The derivation of the Total Assessment Profile is dependent on several preparatory data phases. Figure 80 illustrates the operational format and the proper sequencing of tasks.

PHASE I - ENGINEERING TECHNOLOGICAL EVALUATION

The first phase employs a basic engineering review and evaluation of the technologies impact, costs, and benefits. Included within this analysis would be:

1. Feasibility Study
2. Estimated Cost Effectiveness
3. Direct Benefit Cost Analysis (Optional)

The engineering technological evaluation establishes the feasibility of the innovation and its direct economic impacts. This stage is preparatory to the social impact analysis.

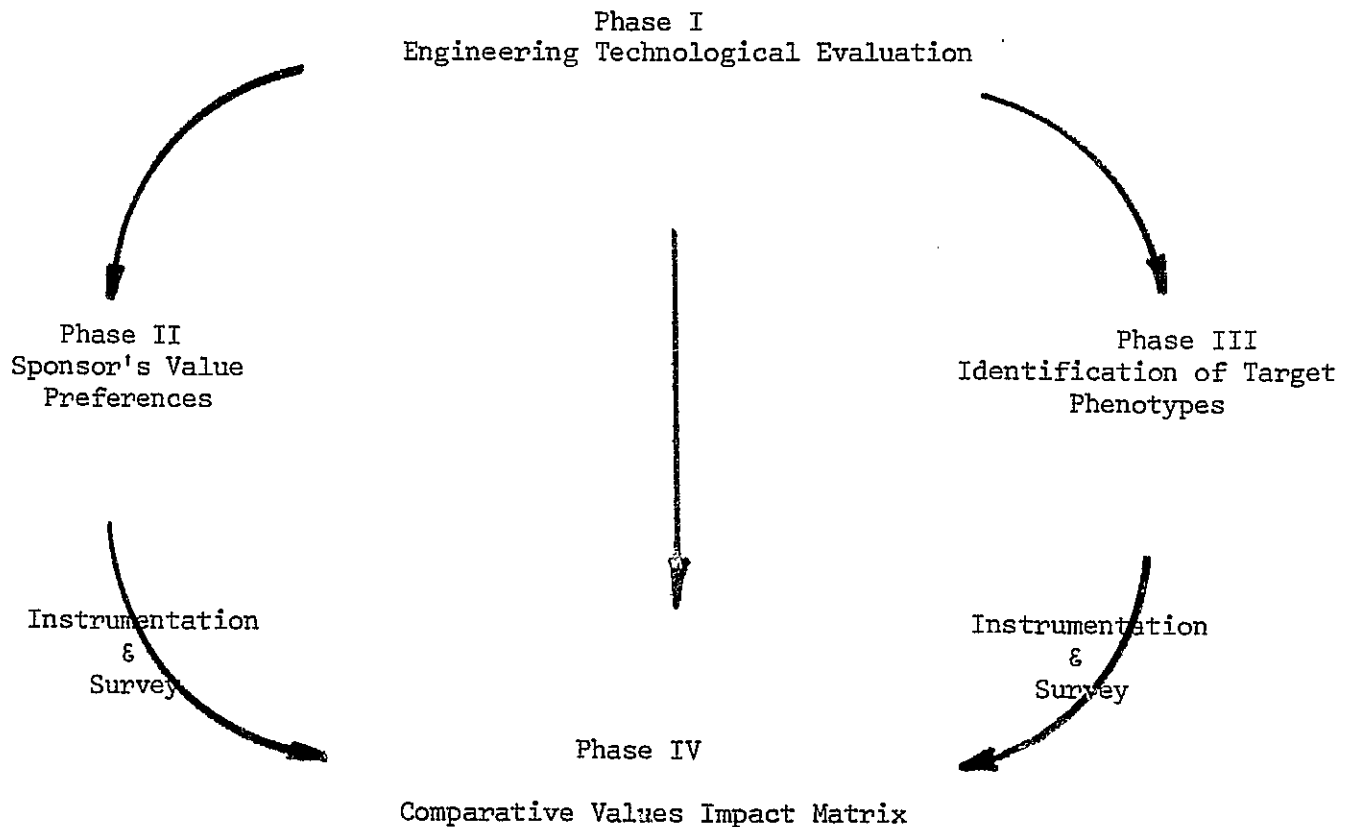


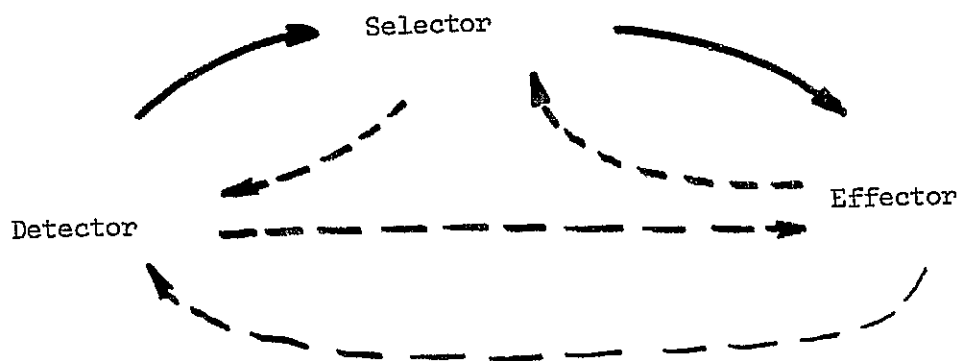
Figure 80. Operational Format For T.A.P.

PHASE II - SPONSOR'S VALUE PERCEPTIONS

It is the objective of this phase to devise the preference impact for the proposed technology as seen by the sponsor. As we just discussed this phase requires the development of instrumentation and a survey of the sponsor. After using MDS to get at the value dimensions the individual responses of the sponsor's representatives are aggregated to a common ordinal scale and then employed in the comparative values impact matrix.

PHASE III - IDENTIFICATION OF TARGET PHENOTYPES

This phase requires the identification of social-psychological phenotypes. In the initial application of T.A.P., a spatial ecological approach is required in the identification of the phenotypes. For details as to how this process is accomplished see Appendix H. This level will permit a relatively simple procedure for defining groups and isolating their size and location. The following behavioral model indicates that Phase III will initially operate at the effector level:



As noted earlier this model illustrates a behavioral process in which the detector stage is representative of the perception of a stimulus. The selector stage illustrates the cognitive action taken by the organism in respect to its perception. The selector stage is largely psychological and is characteristic of covert behavior. The effector stage, on the other hand, defines overt behavior or the physical action taken by the organism in response to the stimulus. Most of the research in the behavioral sciences is dependent on the effector stage (overt behavior) to function as an indicator of covert behavior. The initial application of T.A.P. will not be an exception. Each new iteration of T.A.P. will provide greater understanding and predictability of overt behavior by permitting the researcher greater insight into the elements of covert behavior. The initial application, however, is primarily limited to overt behavioral descriptions and to a survey format geared toward obtaining the elementary components of the cognitive process.

The above will be achieved through the use of a social area analysis approach. This approach will be augmented by a market segmentation analysis to extend the level of inquiry from the effector behavioral stage to the selector stage. This bridge between the two stages will become stronger with each subsequent iteration of the model.

The operational format for Phase III includes the differentiation of space by life cycle and socio-economic dimensions. The regularity in the spatial distribution of these factorial dimensions is documented in earlier sections of this study. Regionalization of the area (see Appendix H) into social areas provides the base for a spatial sampling of occupants. The survey includes instrumentation that is designed to extract the preference structure's of these ecologically based phenotypes.

Since the model is static for both time and space, the phenotypic and sponsor value evaluations remain constant. This is not viewed as a serious limitation in the short-run. However, for long-run applications of T.A.P. systematic updates for value preference structures would be a necessity. This requirement, in fact, may be considered a positive social attribute. Monitoring of changes in the typology of preference space functions as a general indicator of value assimilation and dispersion. Convergence of the value structure, for example, may suggest uniformity in societal goals. This in turn may function as a determinant of public and private policy. On the other hand, increased dispersion would indicate greater segmentation of the society and an increased demand for multiple goals and policies.

In addition, changes in the value space of the society may be employed in a predicative mode to define the directions new technology should follow. Incorporation of the above would represent a major shift in orientation from a society which has traditionally been directed by technology to one which defines the desired technology and its applications.

PHASE IV - THE DERIVATION OF THE COMPARATIVE VALUES MATRIX

The final phase represents the output of the analysis. The scaled value preferences of the phenotypes and of the technology's sponsors are introduced into a matrix format. Comparisons of the rankings are defined in the cells of the matrix. Each matrix inturn provides a profile (Total Assessment Profile) which reveals the impact of the technology on the society.

The comparative values matrix represents the attribute states defined in the utility model. Weighing each of the value configurations by the influence or size of the phenotype, they represent, provides the input into the aggregate utility equation. It may be recalled that the equation reflects a functional relationship for the combined phenotypic groups:

XVII. NATURAL DISASTERS: THE PROBLEM SUGGESTING T.A.P.

1. INTRODUCTION

In the initial stages of the project upon which this study is based a benefit cost study was envisioned. In the beginning our team proposed to go to an area of the United States and perform a benefit cost study. However, financial and other considerations coalesced to rule out this possibility. The alternative suggested was to view the effects of Hurricane Agnes in order to gather supporting data and gain further insights into the "total cost" picture of a disaster. This view necessitated collection of large volumes of disaster related data and searching out the information relevant to both benefits and costs.

In this section of the report the dynamics of a disaster are viewed. The approach is selective in the sense that the Total Assessment Profile is geared to both space and time dynamics. Hence, three major objectives pertinent to our approach are embodied: (1) the need to demonstrate a literature review of sequential sets of disaster behavioral models, (2) the need to define relationships of the sequential profiles to new early warning disaster technology, and (3) the need to establish a mechanism by which sequential profiles of disaster behavior may be integrated into a higher level benefit cost analysis. The goal of the preceding was to design a profiling mechanism for all types of technological assessments. The sequential profiles of disaster behavior are specific and were used to define the universals in the behavior sequences. In other words, the profiles are used inductively to develop a theoretical base upon which all technological assessments may be defined. In this sense we are suggesting a major departure from the traditional cost-benefit analysis. The direction for this departure as has been shown involves placing the theory of social action in a spatial temporal framework.

2. THE SPACE TIME CONTINUUM

The events that occur in objective reality are perceived by man as experiences. These experiences occur within a temporal and spatial continuum. Abler, Adams, and Gould [301] have suggested that the temporal continuum is egocentric and may be divided into formal time regions. Figure 81 illustrates the preceding concept. It shows that consciousness of perceiving events within the temporal continuum are structured in the context of three temporal dimensions: the past, present, and future. The intensity of our experiences is greatest in respect to the present and is characterized by a decay function both into the past and into the future.

Within the spatial continuum a similar diagram may be developed as shown in Figure 82. Man experiences events over space as well as over time [302]. He demonstrates, in the spatial continuum of experiences areal differentials in the intensity of his perceptions of events. If we place man at the center of his space (spatial egocentricity is assumed

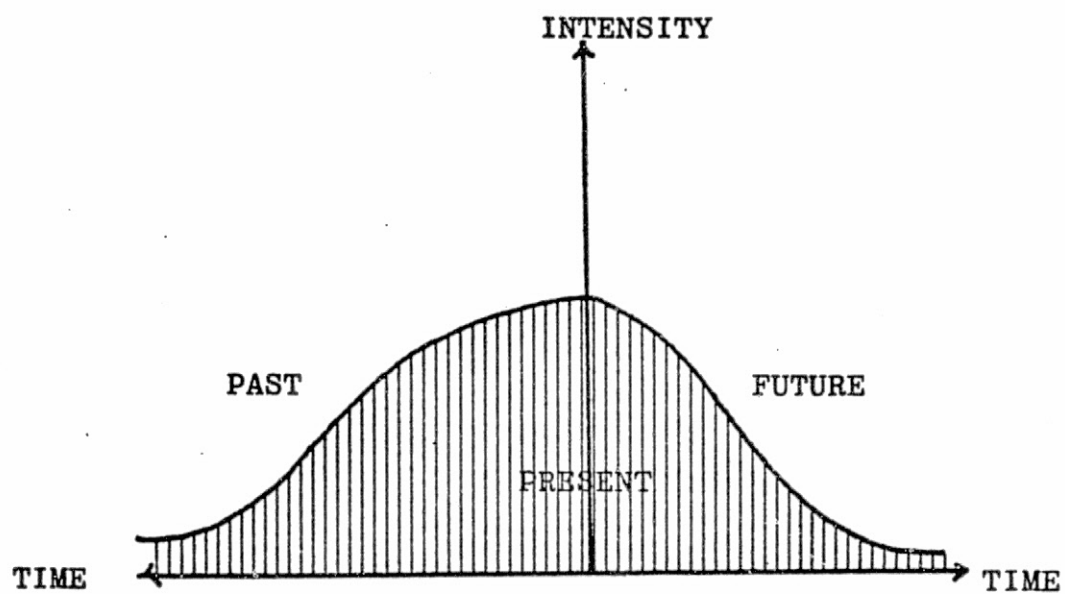


Figure 81 - The Temporal Continuum of Experiences

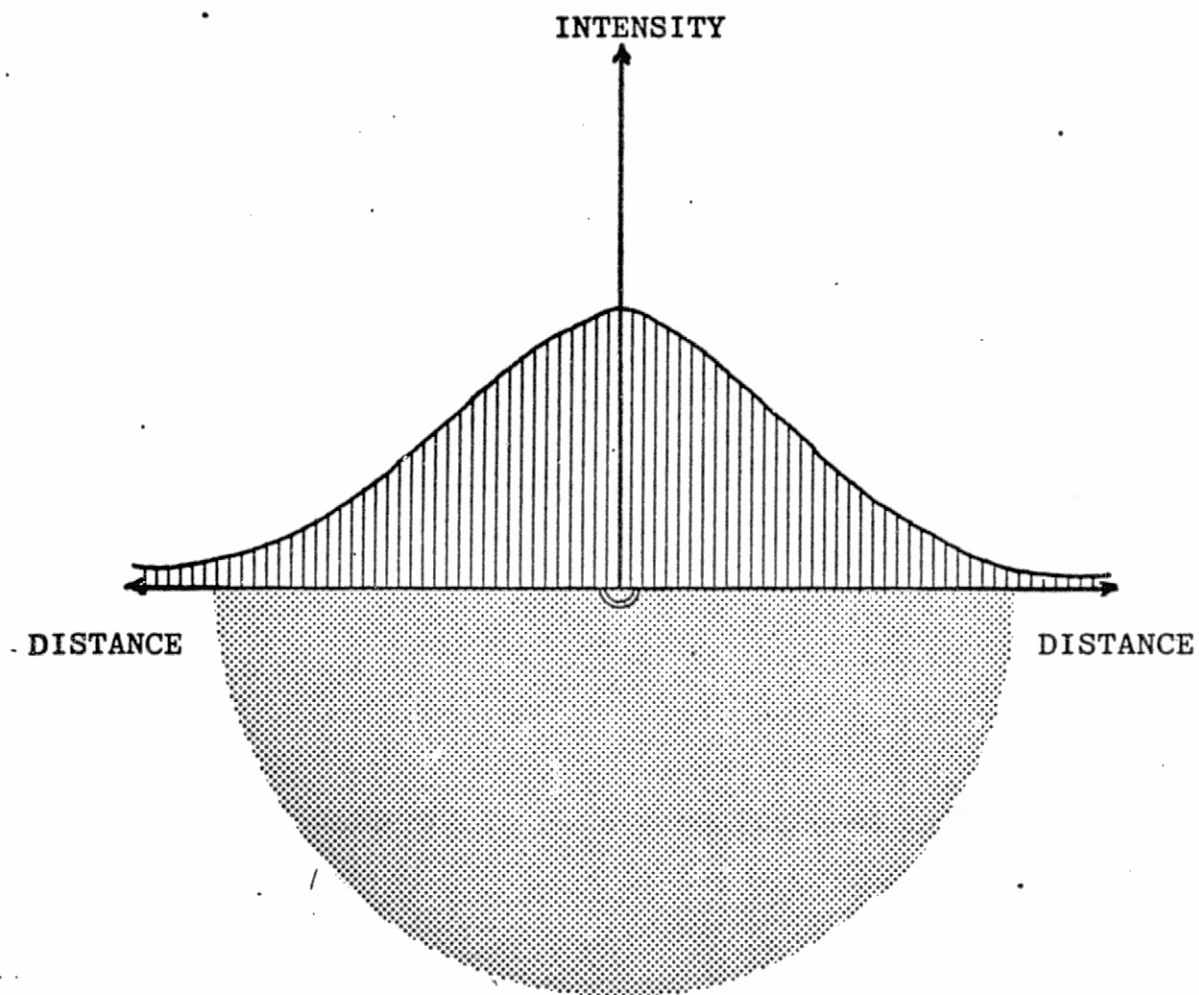


Figure 82 - The Space Continuum of Experiences

in the above and is consistent with most behavioral models) we would anticipate a frictional effect in the intensity of experiences with the distance that the experiences occur in respect to the individual perceiver. Hence, both time and space continuums of experiences demonstrate decreasing intensity with distance from the individual perceiver. We have a nodal (central) structure in which man perceives himself as the center [303] with events both in the context of time and space decreasing away from him.

Time and space become central and unifying dimensions for human experiences. Gould notes that the fundamental nature of time and space is indicated by the lack of a concept to express the absence of these dimensions for experiences [301]. The location of an event is always defined in relation to the preceding continuums.

The large body of literature on disaster behavior reflect numerous individual and organizational changes occurring within a natural disaster context. An initial objective to understanding the similarities and co-variations in these models of behavior necessitates a mechanism by which they may be ordered and evaluated. It is proposed in this paper that the mechanism of ordering these events be a space/time continuum. This approach will facilitate comparisons of numerous sequences of events and establish a means by which these sequences may be calibrated to one another. The interrelationships of these sequences may then be utilized in the derivation of a social action theory.

Since, both the time and space continuums illustrate a decay function it is suggested that a logarithmic scale be defined [304]. Figure 83 illustrates the proposed scale which would be applicable to both temporal and spatial event sequences. Interpretation of the scale reflects a temporal dimension generated from a specific event at time t with the lower portion of the scale reflecting post events from time period t to $t+9$ and the upper portion of the scale indicating the pre-event period from time unit $t-9$ to t .

3. MODELS OF DISASTER - THE TEMPORAL SEQUENCE

Most researchers confronted with the study of events such as a natural disaster have attempted to sequence these events within a temporal stage model. The simplest of the temporal models is provided by Drayer [305] in which the disaster is seen as the impact, with the pre-disaster phase and post-disaster phases defined as the pre-impact and post-impact stages respectively. Carr [307] and Smith [308] provide a slightly more elaborate stage model in which the post-disaster phase is subdivided into additional stages. The Carr and Smith approaches provide greater sensitivity to the abrupt structural changes following the onslaught of the disaster. Models by Form [309], Williams [310], Powell [311], Wallace [312], Ellevers [313], and Stoddard [314] are very detailed stage models of disaster phases both in the pre and post-disaster periods. In all cases the above models

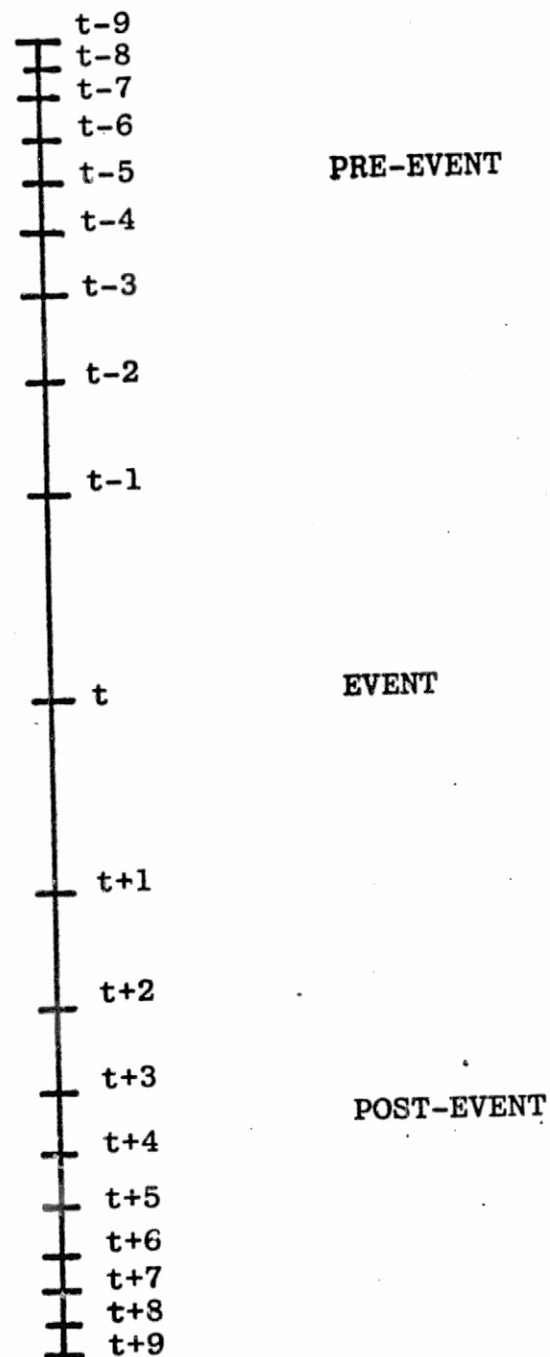


Figure 83 - The Temporal Logarithmic Continuum of Event Sequences

structure similar reaction and preparatory behavior by organizations and individuals in respect to a temporal continuum. Figure 84 reviews these various models of temporal sequence stages on the transformed logarithmic scale proposed earlier.

One of the most popular stage models of disaster behavior over time is found in Powell's approach. A breakdown of this model calibrated to the logarithmic scale is provided in Figure 85. Along with the calibration to the logarithmic scale functional descriptions of the stages are provided in the figure. The exact location of the stages are dependent on the nature and agent of disaster. Hence, the warning period could be of substantial length in some types of disasters or in other types their could be an absence of the pre-warning phases. The preceding necessitates a classification of disaster agent characteristics to the calibration of the temporal stages. The Disaster Research Center (DRC) at The Ohio State University has provided several publications related to disaster agents and their characteristics [306]. The following characteristics were felt to be important considerations in disaster planning: predictability (how foreseeable is the event), frequency (is the event rare or common), controllability (is intervention or control possible), speed of onset (how sudden is the impact), duration of impact (the length of the impact period), length of forewarning (length of period prior to impact), and the intensity of impact (a combination of both location and degree of the impact). To summarize these findings of the Disaster Research Center Figure 86 has been constructed to illustrate the preceding concepts as they relate to a selected set of specific disaster agents.

Several problems are encountered in the utilization of Figure 86 as a taxonomic structure for the study of natural disasters. Most disasters of a large scale are the result of multiple agents and we would expect the effects to be multidimensional. For example, a hurricane could potentially involve flooding, wind damage, fire, etc. Hence a multiplicity of effects may be associated with the onslaught of this one disaster. We may also find within each disaster agent wide variations in its characteristics. For example, a flood may range from a highly predictable and generally controllable event to a flash flood which may be very unpredictable and generally uncontrollable. Dynes, Quarantelli, and Kreps [306] note that the most severe combination of the preceding characteristics are in a disaster agent that gives little or no warning, that has a rapid onset, and that lasts a long time.

The temporal phases in the disaster are arbitrary, but each phase does represent changes in values and new demands for human action. Both for convenience and its sensitivity to these changing demands the temporal sequence established by Powell will be utilized in our treatment (Figure 85). Powell established eight phases in his temporal model:

Phase I Predisaster Phase - This phase establishes the setting prior to the detection and occurrence of the event. It represents the adaptations that the society has provided for a disaster occurrence.

	Carr	Drayer	Smith	Form	Powell
t-9	Preliminary or Normal Period	Pre-Impact	Preparation and Training	Pre-Disaster Phase	Pre-Disaster Condition
t-8					
t-7					
t-6					
t-5					
t-4					
t-3					
t-2					
t-1	Impact	Impact	Threat	Pre-Emergency Phase	Threat
t					
t+1					
t+2					
t+3					
t+4					
t+5					
t+6					
t+7	Dislocation and Disorganization	Post-Impact	Post Impact or Emergency Relief	Period I	Inventory
t+8					
t+9					
t+10	Readjustment and Reorganization	Post-Impact	Temporary Rehabilitation	Period II	Rescue
t+11					
t+12					
t+13	Readjustment and Reorganization	Post-Impact	Permanent Rehabilitation	Period III	Remedy
t+14					
t+15					
t+16	Readjustment and Reorganization	Post-Impact	Permanent Rehabilitation	Post Emergency Phase	Recovery
t+17					
t+18					

Figure 84 - Temporal Disaster Sequence Models

	Wallace	Ellevers	Stoddard	Williams
t-9	Steady State		Pre-Emergency Phase	Adjustive Phase
t-8				
t-7				
t-6				
t-5	Warning and Threat	Warning	Emergency Phase	Protective Phase
t-4				
t-3				
t-2				
t-1	Impact	Threat	Threat and Evacuation Stage	Impact Phase
t				
t+1				
t+2				
t+3	Isolation	Rescue	Relocation Stage	Survival Phase
t+4	Rescue			
t+5	Rehabilitation			
t+6				
t+7	Irreversible Change	Restoration	Post-Emergency Phase	Integrative Phase
t+8				
t+9				
			-Short Term Rehabilitation	
			-Long Term Rehabilitation	

Figure 84 - Continued

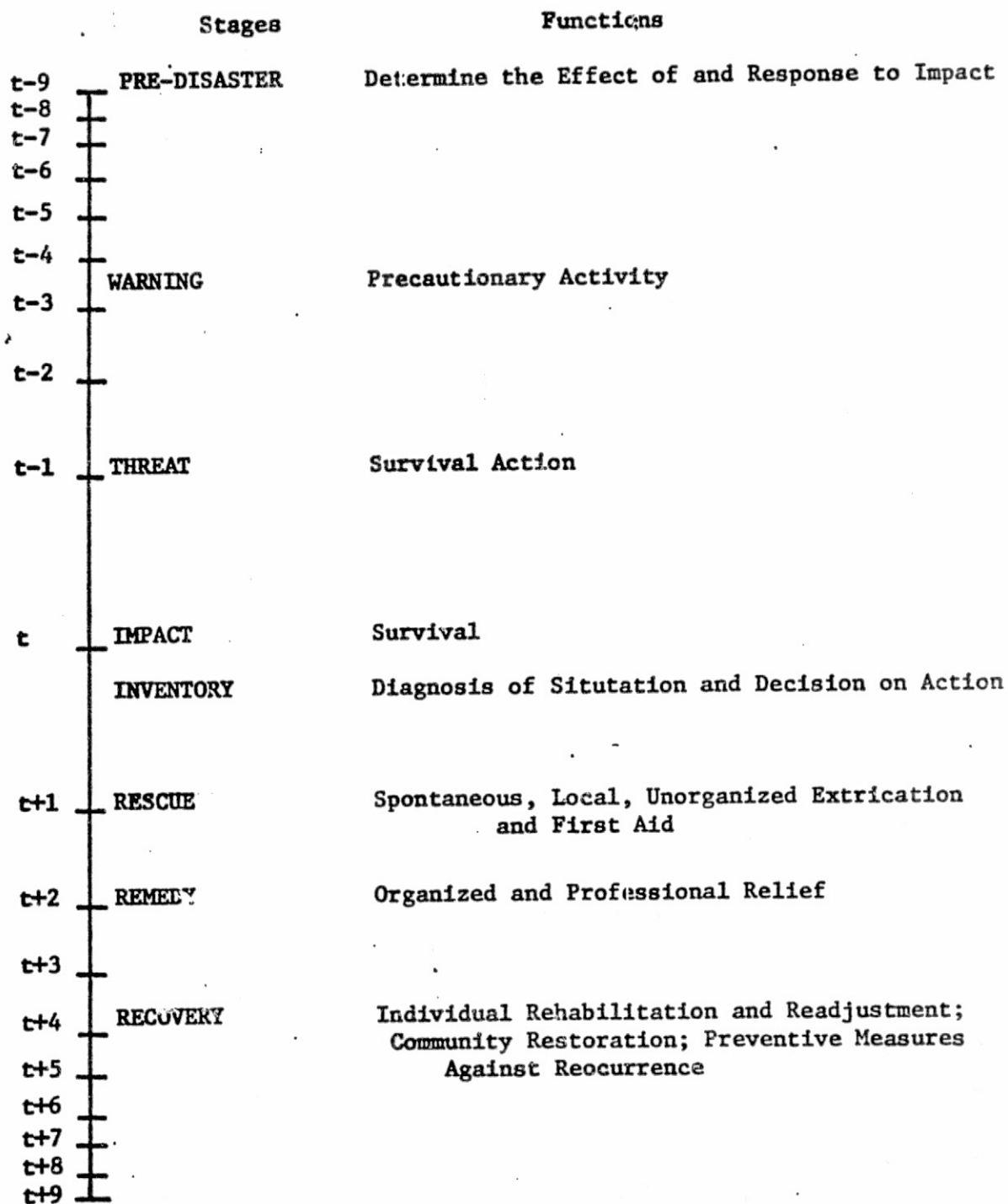


Figure 85- Powell's Temporal Disaster Stage Model

Natural Disaster Agent	Predictability	Frequency	Controlability	Speed of Onset	Length of fore-Warning	Duration of Impact	Intensity of Impact
Floods	High	Frequent	Potential Control	Relatively Slow	Several Days	Extensive	Dependent on Location
Wind	Limited	Frequent	Limited Control	Relatively Fast	Limited	Relatively Short	Generally limited
Earth Quake	Limited	Relatively infrequent	None at this time	Rapid	Very limited	Relatively Short	May be Widespread
Tornado	Limited	Infrequent	None at this time	Relatively Fast	Limited	Short	Limited Impact Area
Hurricane 373	High	Infrequent	Very Limited	Relatively Slow	Several Days	Relatively Short	Relatively Widespread
Tsunami	Moderate (Cause-Effect)	Infrequent	None at this time	Relatively Fast	Limited	Short	Relatively Widespread
Fire	Moderate Predictability	Frequent	Potential Control	Rapid	Very Limited	Generally Short	Generally Limited
Blizzard	High	Frequent	Very Limited	Relatively Slow	Limited	Relatively Short	Relatively Widespread

Figure 86- Selective Disaster Agents and Their Characteristics

- Phase II Warning - Most writers feel this stage is associated with advance notification of the existence of danger and what can be done to prevent or minimize the impact [315,316].
- Phase III Threat - This phase is seen as a preparatory stage to the impact. The phase provides time to ready resources and institutions to minimize the consequences of the disaster.
- Phase IV Impact - This phase is normally of short relative duration and consist of the period where the disaster agent is active. It should be re-emphasized that this phase may consist of multiple impacts.
- Phase V Inventory - This phase follows the disaster and is used to assess the demands that the disaster has created. In most situations we may view this stage as an initial personal inventory and later expect it to represent a translation to a community level inventory. This is an extremely important phase for it establishes the direction and magnitude of the mobilization effort.
- Phase VI Rescue - This phase consists of the immediate demands generated from the impact and its subsequent inventory. Victims are identified and immediate aid is provided by either ephemeral or organized established institutions.
- Phase VII Remedy - This phase is an extension of the Rescue phase and consists primarily of organized professional aid.
- Phase VIII Recovery - This phase is associated with the restoration of the impacted area to a level comparable to the pre-disaster phase. Recovery may take an extended period of time and may include adaptations to reduce subsequent disaster impacts.

The preceding stages provide numerous demands on the community and results in adaptive and sometimes conflicting behavior. This model, however, does provide an arbitrary regionalization on the temporal continuum that may be used to isolate behavioral responses by both individuals and the community at large to events associated with a disaster.

4. MODELS OF DISASTER - THE SPATIAL SEQUENCE

The spatial continuum of disaster behavior may be demonstrated by a model developed by Anthony Wallace [312] for a tornado in Worcester, Massachusetts. Figure 87 illustrates Wallace's spatial model transformed to the temporal logarithmic scale. According to Wallace the warning and

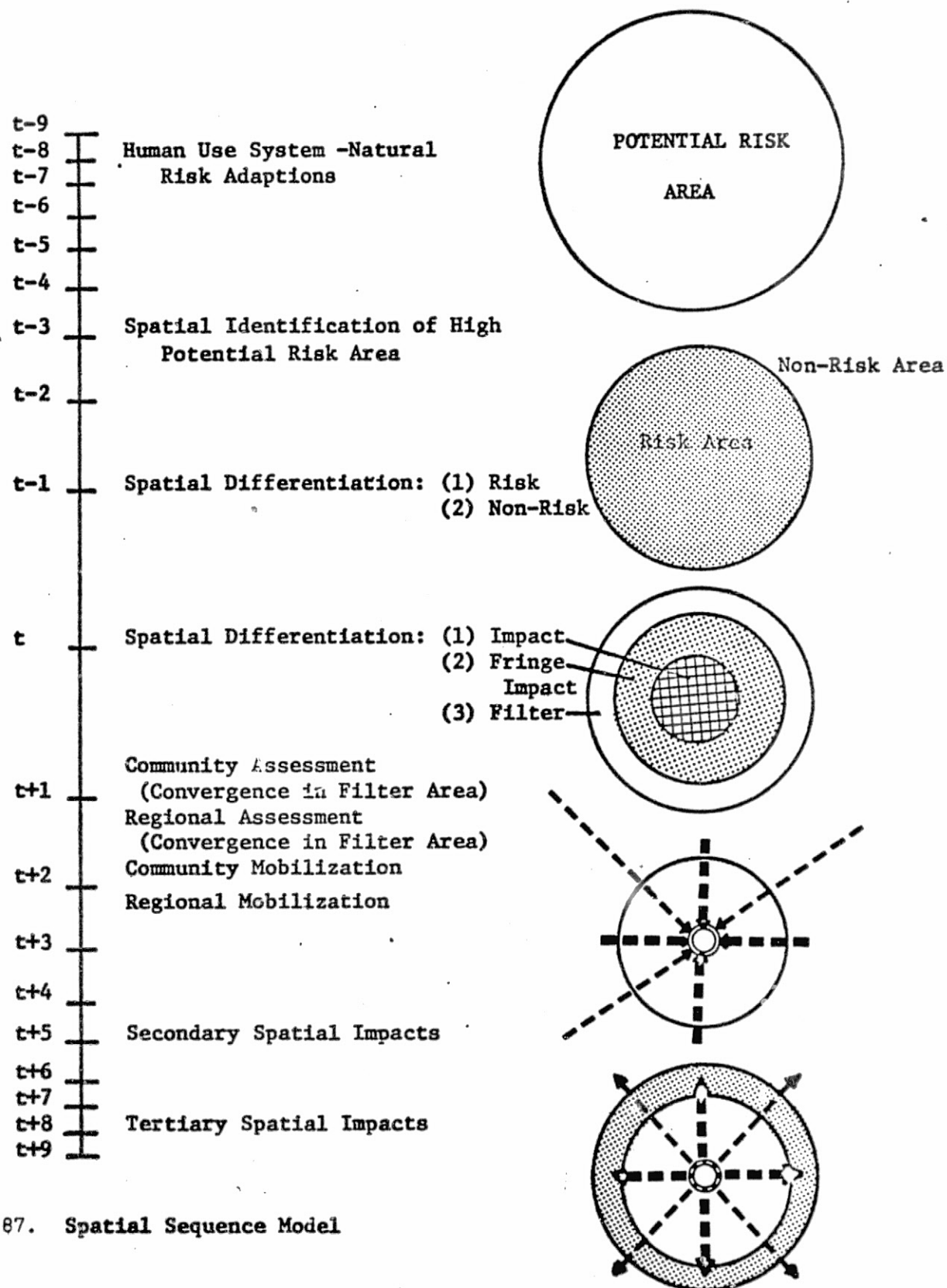


Figure 87. Spatial Sequence Model

threat periods are characterized by increasing spatial differentiation in the area where the disaster is likely to occur. As environmental cues are observed and information is disseminated an area of high risk is identified. It is within the high risk areas that mobilization and response to the impending danger would be greatest. At the time of impact even greater spatial differentiation is observed. Wallace defines three potential zones at this stage: a total impact area where maximum damage has occurred, a fringe impact area which has experienced a secondary degree of damage, and a filter area which was undamaged, but functions as a convergence zone for disaster relief efforts. The size of the disaster as it is defined by the area enclosed within the filter area provides an initial measure of the inventory or assessment phase of the mobilization efforts to follow. Since the disaster impact reflects differential spatial intensity it may be expected that both secondary and tertiary impacts will also demonstrate areal differentiation.

Wallace's model for the phases of the disaster over space reflects a geographic static model of areal differences (zonal patterns) that exist at a single node (point) in space. Many disasters are dynamic over the spatial continuum and should be viewed as a spatial diffusion process. Within an expansion type diffusion process, a disaster occurring over space would be viewed as a directed graph. A biased net of destination nodes would demonstrate the transfer over space of the total impact, fringe impact, and filter areas from an origin node to destination nodes. Figure 88 illustrates the dynamics associated with an expansion diffusion system. The temporal impact stage, in the context of Figure 88, would illustrate a primary wave effect over the graph (surface). A disaster, such as a hurricane, would reflect this spatially dynamic characteristic as one identifies and tracks the storm along its path.

The dynamic combination of time and space provides a dimension that may be utilized in the study of all disaster sequences. Following the primary way of destruction subsequent waves of secondary and tertiary impacts may be generated. Crucial to the cost-benefit analysis proposed, is a treatment of both the traditional costs and benefits associated with the primary wave, and the important secondary and tertiary impact wave. It is assumed that the social and institutional costs of the disaster are more likely to be reflected in these secondary wave effects.

The preceding has suggested that the sequence associated with the disaster will reflect changing demands and will result in complex forms of social action. The costs and benefits of these actions must be defined prior to an assessment of technological innovation in changing expected sequences. To provide a frame of reference for this assessment a series of profiles have been constructed and calibrated to the logarithmic temporal/spatial continuum.

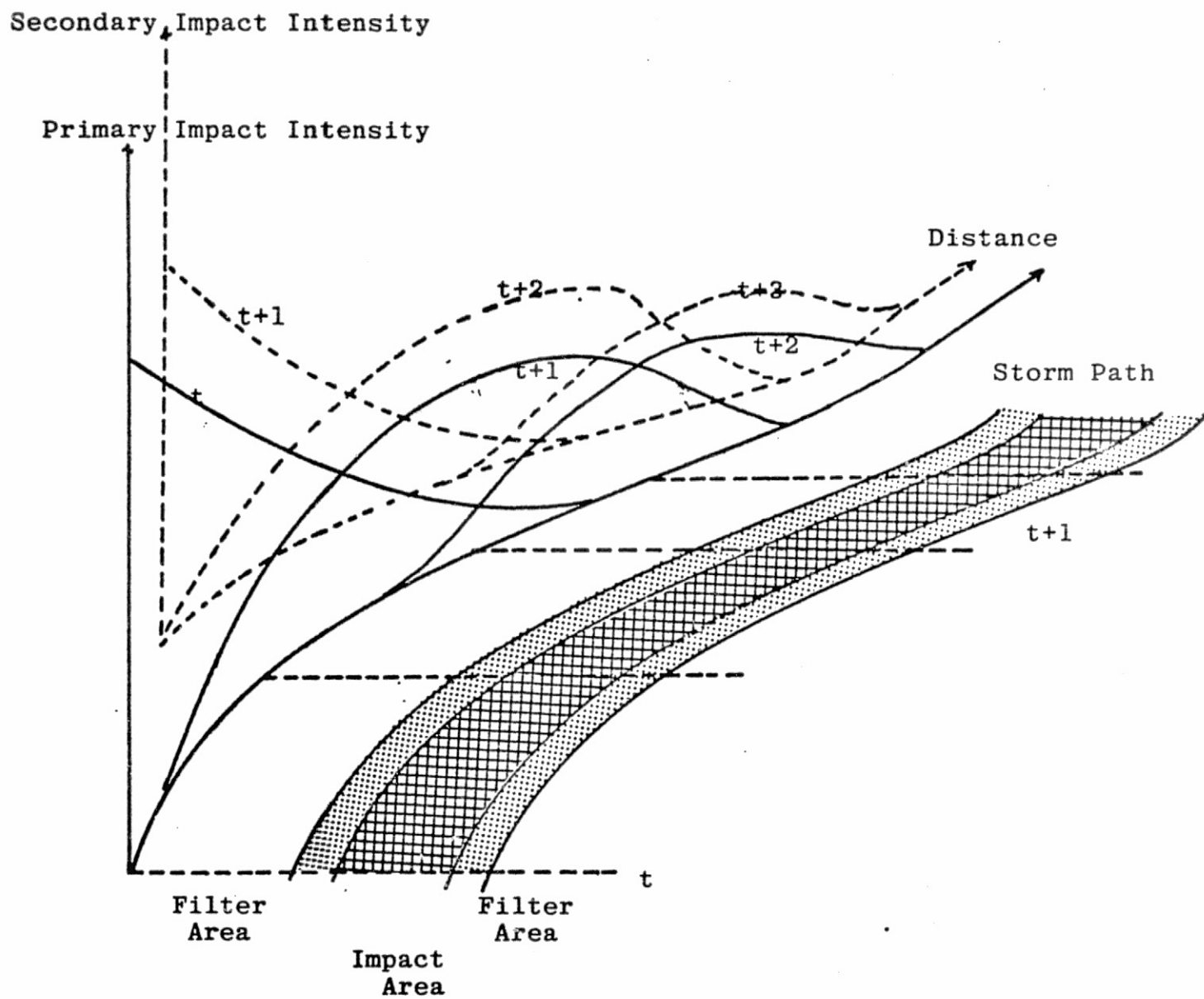


Figure 88 - A Spatial Diffusion Disaster Model

5. THE COMMUNITY FUNCTION PROFILE

Figure 89 illustrates the changing community functions associated with the pre and post-disaster phases. Basic community functions such as: production-distribution-consumption, socialization, social participation, social control, and mutual support are disrupted at the approach and immediate periods following the impact phase. During the impact there is a shift to core or axiomatic values. This disruptive effect and the length of time following its restoration implies both an economic and social cost to the community. During the impact phase we see a shift from the normal external linkages (vertical linkages) to horizontal (internal) linkages within the community [317]. The normal functions of that community are no longer effectively operating and are not re-established until the remedy and recovery phases.

6. THE ORGANIZATION SEQUENCE PROFILE

Figure 90 provides a transformation to the logarithmic scale of an organizational sequence profile. Dynes [318] has identified four types of organization components within the context of disaster behavior. Dynes' basic typology is illustrated in Figure 91 and reflects two key concepts. Those organizations that have tasks either associated or not associated with disasters and those organizations that are old and established in relation to those that are new and of an emergent character. From this typology four primary organization types may be defined:

- Type I Organizations Established - These would represent organizations that are clearly responsible for disaster related activities. Examples of the following would include police and fire departments.
- Type II Organizations Expanding - Dynes sees these groups emerging from community organizational planning. At the time of a disaster their role is defined, however they must mobilize and expand their structure to become effective. An example of a Type II organization is the American Red Cross or the Salvation Army.
- Type III Organizations Extending - This organizational type defines a group which is in existence prior to the disaster, however, it radically changes its role in response to the needs. In other words, the organization undertakes non-regular tasks. An example of a Type III organization would be a construction company utilizing its equipment and employees in a rescue operation.

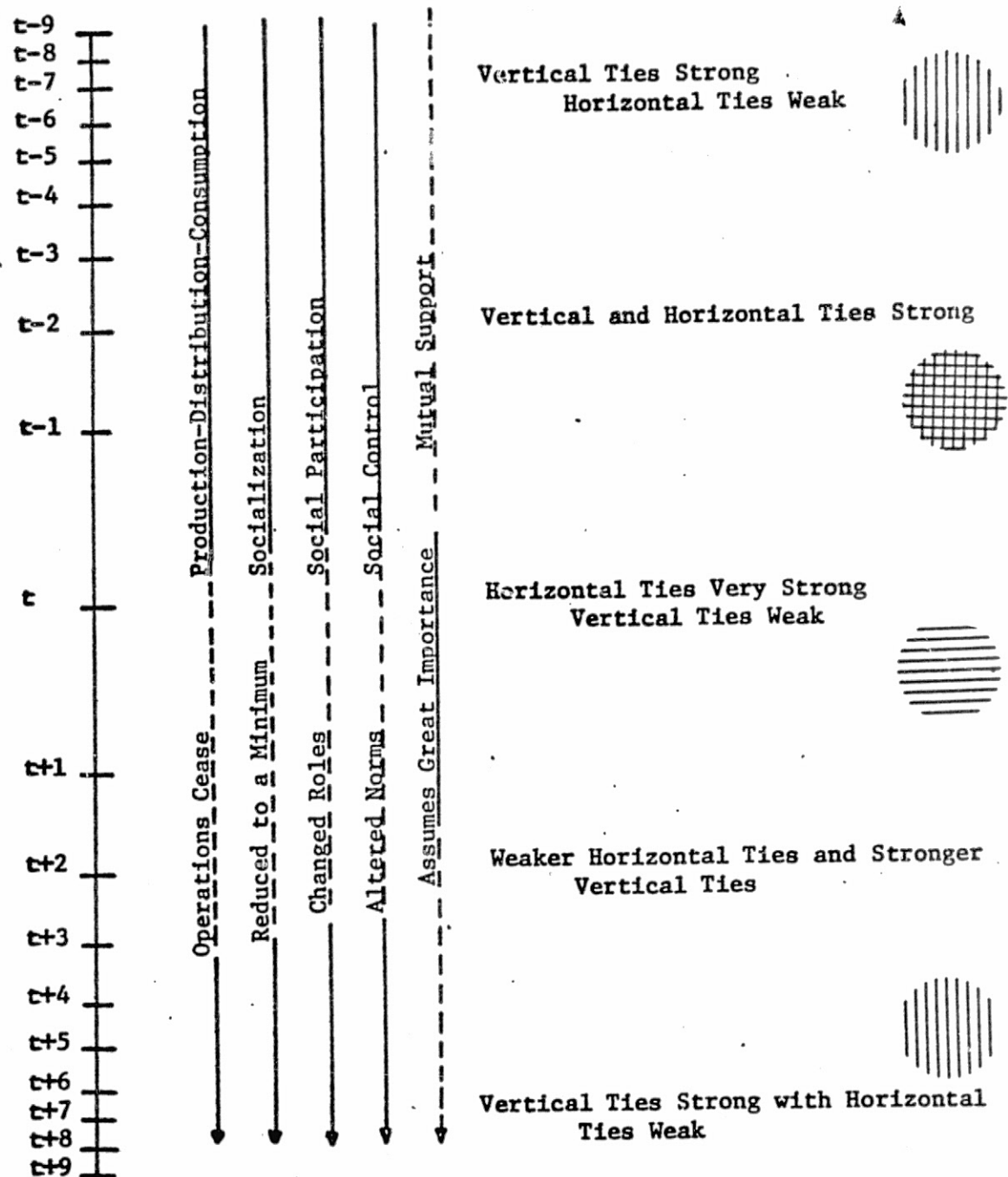
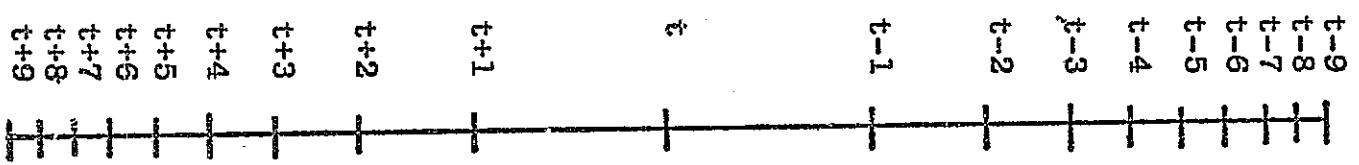


Figure 89. Community Functions and the Temporal Continuum



TYPE 1 - ESTABLISHED ORGANIZATIONS

TYPE 2 - EXPANDING ORGANIZATIONS

TYPE 3 - EXTENDING ORGANIZATIONS

TYPE 4 - EMERGENT ORGANIZATIONS

Figure 90 - Organizational Type Sequence Profiles

		TASKS	
		REGULAR	NONREGULAR
STRUCTURE	OLD	Type 1 - Established	Type 3 - Extending
	NEW	Type 2 - Expanding	Type 4 - Emergent

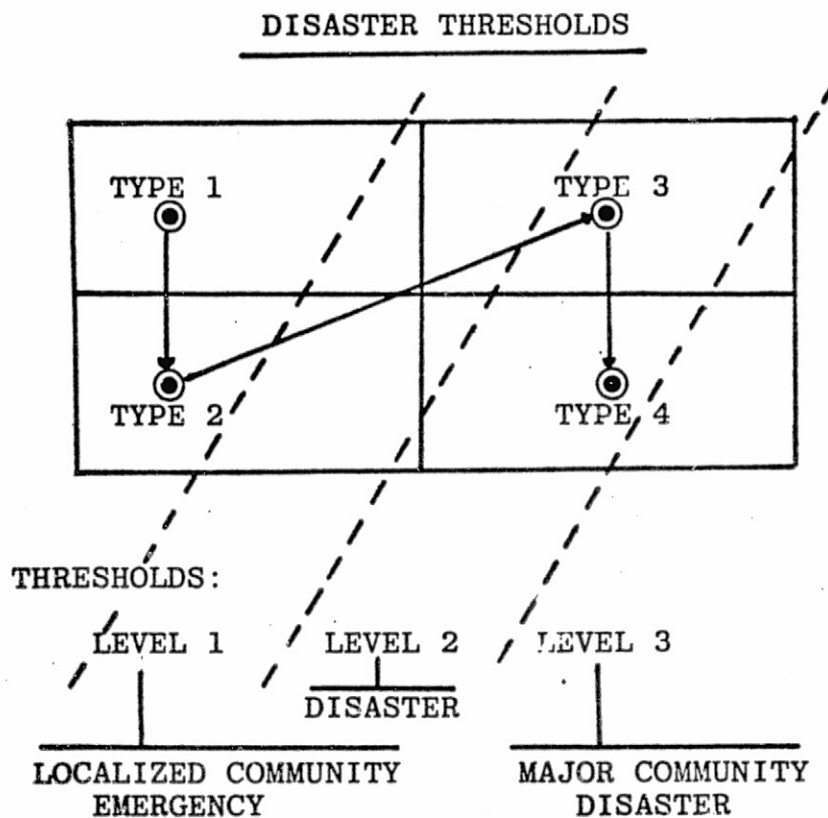


Figure 91 - Organization Type and Disaster Magnitude

Type IV Organizations Emergent - This organizational group would be of a new-nonregular type when it becomes engaged in disaster oriented activities because of emergent needs. This type of group would have no previous experience nor structure and would be forced to establish all the basic organizational elements following the impact. An example of a Type IV organization would be a citizen's investigation or relief committee.

It may be observed from Figure 91 that based on the type of organizations that are activated during an emergency a threshold disaster level may be defined. The existence of Type I and Type II organizations would reflect the level of a localized community emergency. The addition of Type III organizations provides a threshold to attain a full scale disaster level emergency. The addition of Type IV organizations expands the disaster to a major emergency level. The profile sequence for organization structure is provided in Figure 91. Type I organizations having already been established, are in existence and operating through the entire time sequence. As the impact phase is approached mobilization of resources are placed in an emergency mode. Type II organizations also exist through the entire time period, however, they would not undergo their functional expansion phase until the inventory stage. Type III and Type IV organizations would emerge as a necessary response to community demands following the impact phase. The articulation of Type III and Type IV organizations in respect to Type II may result in various degrees of stress [319,320]. Type III and IV organizations represent non-professional local volunteer groups relative to Type II organizations that may represent professional and often nonlocal people. The preceding may result in both role and goal organizational friction. In most disaster situations Type III and IV organizations dominate the immediate post impact phase with Type II organizations becoming central during the relief and early recovery phases.

7. THE COMMUNICATION SEQUENCE PROFILE

The communication sequence model reflects a dichotomous structure between senders and receivers of information. The major function of the communication sequence profile as presented in Figure 92 is to provide information during the warning and threat, impact, and inventory phases. The senders are responsible for detection of environmental cues, pre-diction of the likely implications of the cues, and finally dissemination of information in the form of a warning. These warnings may continue throughout the pre-impact and the impact phases of the temporal sequence. The senders system may actually consist of an information hierarchical linkage network with numerous levels of senders [316]. The structure, for example of the U.S. weather service reflects a highly articulated information dissemination.

The reception of the sender's messages involves an alert to potential victims and consists of an evaluation phase by the receivers. Extensive

C-5

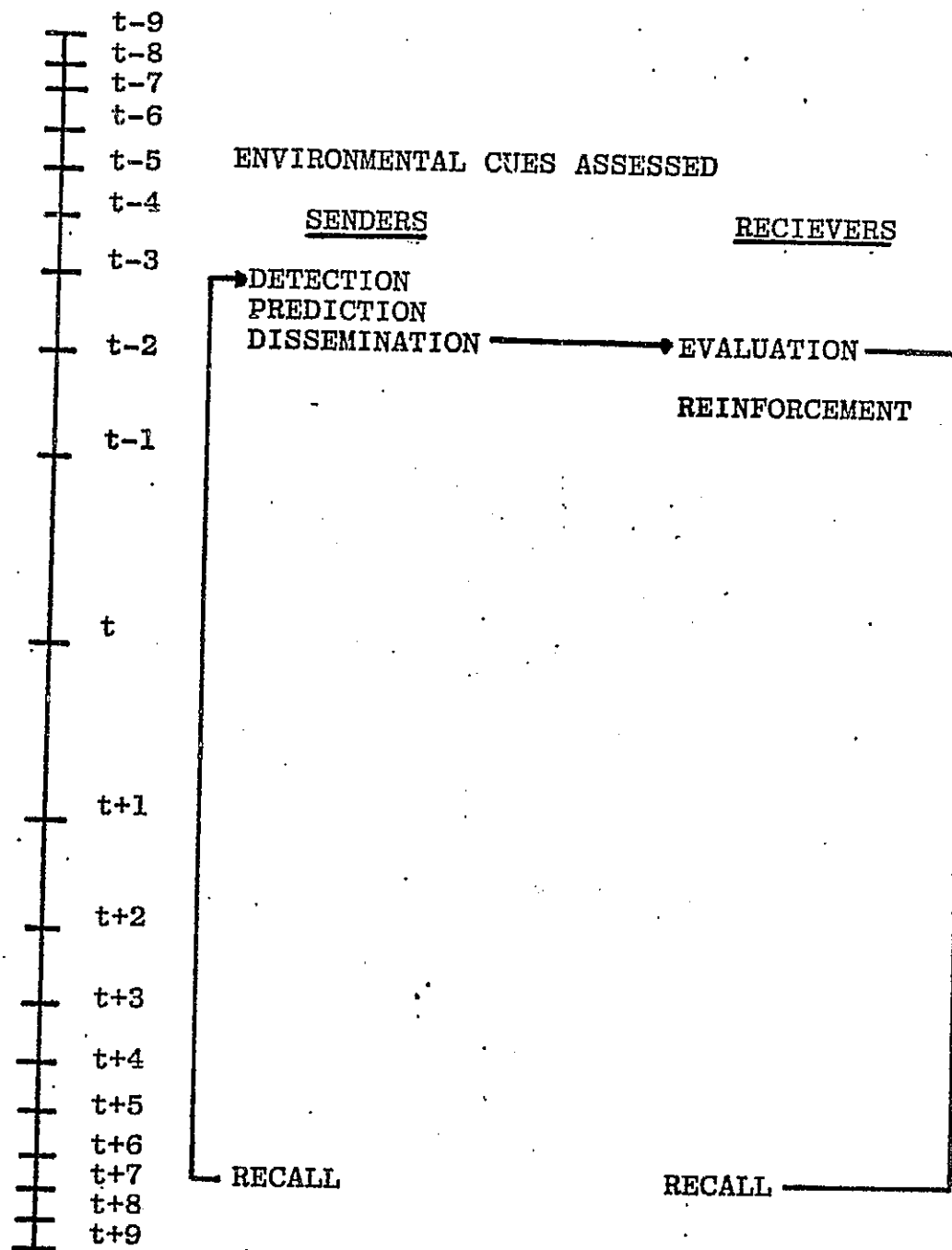


Figure 92 - Communication Sequence Model

research has indicated that responses to environmental cues will reveal substantial variations by region and socioeconomic phenotypes [217,321, 322,187]. The individual perception of the seriousness of the threat and the identification of the response to it defines the effectiveness of the communications network. McDavid [323] observes three major determinates by receivers in the effectiveness of the communication system: (1) the reliability of the source, (2) the perceived meaning of the information, and (3) the resolution of conflicting information [323].

A reinforcement phase continues throughout the warning, threat, and post impact periods to bolster and augment the initial information flow. The communications profile incorporates a learning phase in the form of a recall loop which provides a feedback both to senders and receivers. It is through the recall mechanism that a latent response pattern for future disaster may be established.

8. THE ADAPTIVE SYSTEM SEQUENCE PROFILE

The previous profile has suggested that a learning component may be established within the response pattern. Figure 93 is a modified and temporally calibrated model of an adaption sequence defined by Kates [186]. The profile defines several stages within a perception learning format. The predisaster phase reflects existing human and natural environmental adaptations. Based on prior learning, cues generated from the natural environment are detected and interpreted by individuals responsible for monitoring natural event occurrences. It is from these cues that the decision maker must establish the degree of threat associated with the cues, and whether to release this information to the general public. Whether the decision maker acts or not this will have no effect on the sequence of natural events. Thus, the above decision rests with the perceptions of the decision maker, delays in his decision to act may have serious consequences on the length of the warning and threat preparatory periods. Following the impact phase a second decision threshold emerges. At this point the decision makers are faced with the problem of mobilization. Extensive economic and social costs are associated with this level. During the inventory phase decisions related to the magnitude of the impact must be assessed. As a result of the sequence of natural events and the decisions associated with these events learning and adjustments may follow.

In the recovery phase these adjustments may take two directions: natural event modification, or human use modification. The above modifications establish a new level of response in the pre-disaster systems. This new adaption may be more resistant to a re-occurrence of the disaster and its impact. The institutionalization of this adaption or series of adaptations has been defined as the emergence of a "disaster subculture" by Wenger and Weller [324]. Considerable variations have been demonstrated in the level of the "disaster subculture" throughout communities in the United States [324]. The Hazard perception research in geography also demonstrates extensive analysis of both the mechanisms for modification and the related human responses to these modifications [322,325,326,327].

t-9
 t-8
 t-7
 t-6
 t-5
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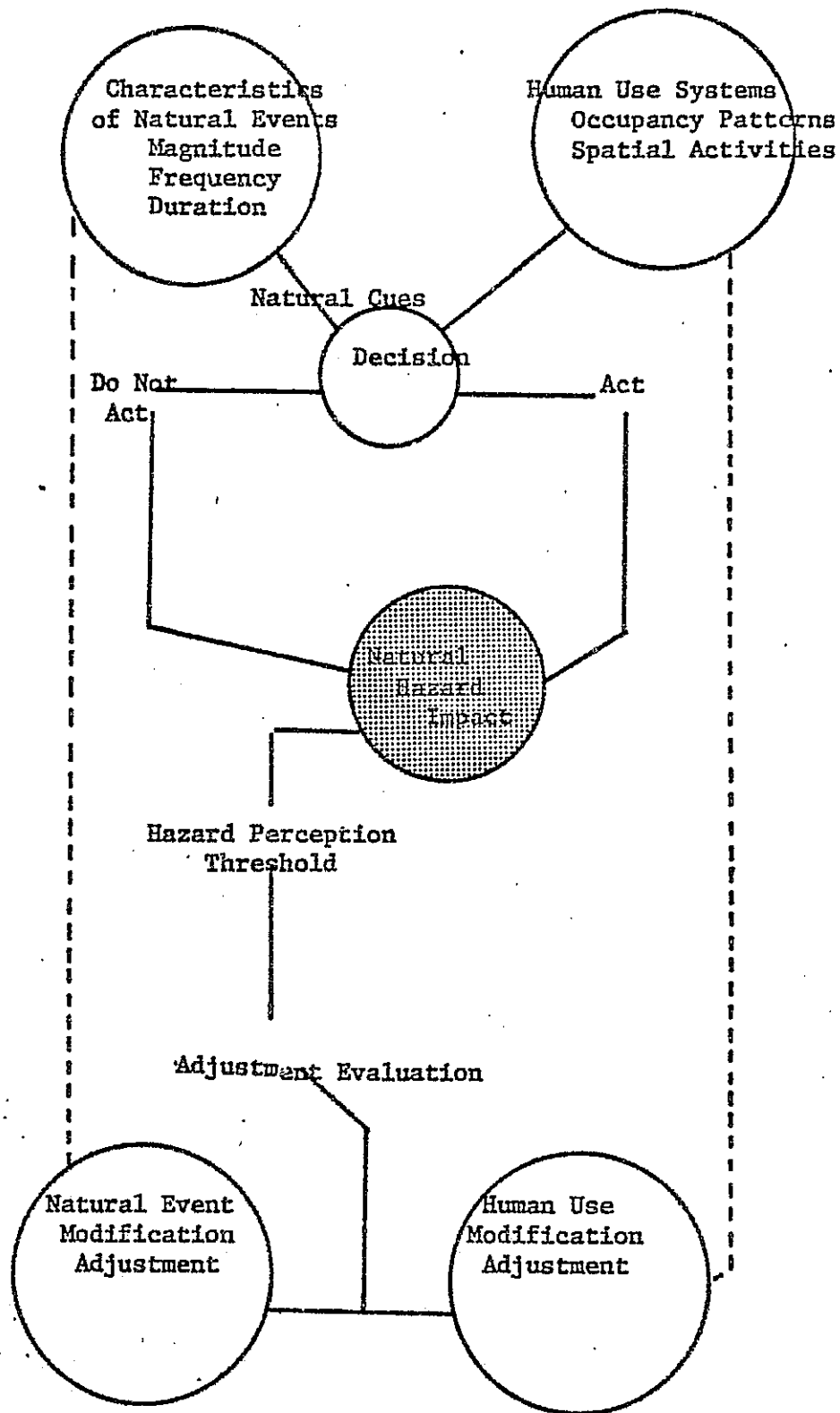


Figure 93 - Adaptive System Sequence Model (Learning Model)

9. THE VICTIM SEQUENCE PROFILES

The preceding profiles have dealt with aggregate reactions to the impact. The victim sequence profile demonstrated in Figure 94 represents an individual reaction sequence to the pre-impact and post-impact phases. The pre-disaster phase is characterized by the individual adaptations to the environment in which human occupancy is established. The perception of risks exists within a conceptual model defined by the individual. Human behavior is the result of actions made in response to objective reality after it has been filtered by values an individual possesses. Hence, irrational behavior may characterize human perception and reactions to environmental risks. The evaluation phase and disaster responses to risk will be determined by the individual perception of the potential danger. Substantial variations in individual responses may be anticipated during the pre-impact phases.

The impact phase would be characterized by a basic survival response, and for most people this response will be demonstrated by meaningful, rational, and protective behavior. Following impact some disorganization may be exhibited by victims; however, research has suggested that this disorganization rapidly dissolves and behavior follows a counter disaster (striking back at the disaster agent) reaction [328,329]. In the latter stages of post-impact the initial "counter disaster syndrome" begins to exhibit greater individual interest and we see greater identification of the victim role emerging among the impacted population. The preceding reflects the input of the professional organizations and directed aid only made available to victims. In respect to the individual, the recovery phase will reveal the greatest impacts as people attempt to re-establish themselves and the realization of the full magnitude of the loss becomes apparent.

10. THE NON-VICTIM SEQUENCE MODEL

The final profile, also reflects the reaction of individuals rather than aggregate group behavior. The non-victim sequence model indicates that the pre-disaster phases will be identical to the victim sequence model (Figure 95). In the post-impact period, however, nonvictims can be placed in a basic dichotomy: those involved in the post disaster recovery reaction, and those who remain uninvolved. Those that elect to become involved may enter the disaster response reaction immediately as volunteers or indirectly from a sightseer role. The typology developed by Shaskolsky [330] provides some direction as to who is placed in a volunteer role (Figure 96). The typology reflects both individual and group volunteerism within an anticipated and spontaneous format. Anticipated individual action may be expected from a physician, while spontaneous individual responses may be expected from the sightseer. The response by volunteers during the rescue phase reflects the transfer of the "counter disaster syndrome" to nonvictims. The emergence of ephemeral groups and

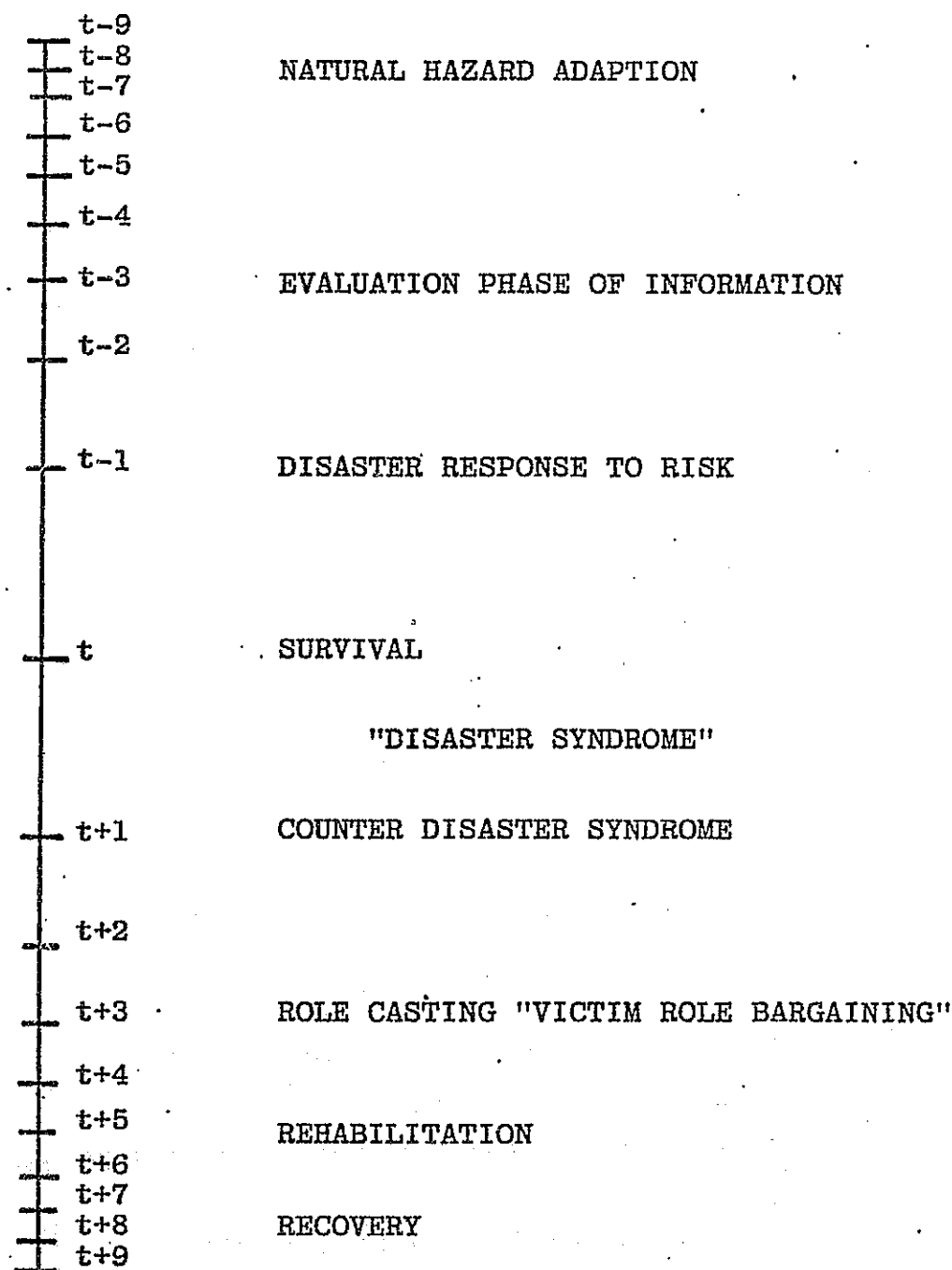


Figure 94 - Victim Sequence Model

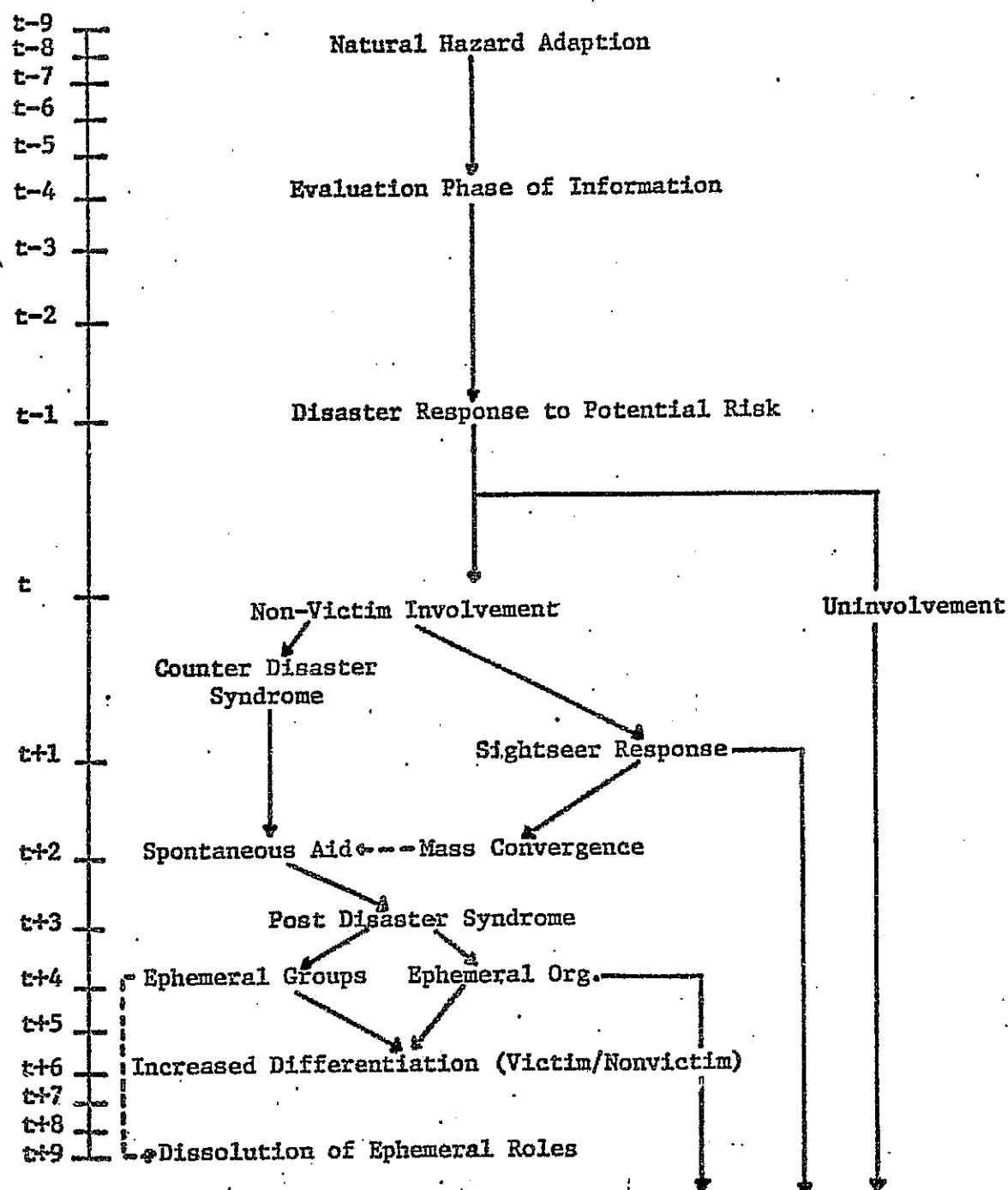


Figure 95 - Non-Victim Sequence Model

A TYPOGLOGY OF VOLUNTEERISM IN DISASTER SITUTATIONS

	INDIVIDUAL	ORGANIZED
ANTICIPATED	DOCTOR	REGUALR VOLUNTEER FIREFIGHTER
SPONTANEOUS	SEARCH AND RESCUE BY BYSTANDER	NONREGULAR VOLUNTEER FIREFIGHTER

TYPES OF VOLUNTEERISM:

1. SPONTANEOUS INDIVIDUAL VOLUNTEERS - ASSISTANCE ON A PURELY INDIVIDUAL BASIS
2. ANTICIPATED ORGANIZATION VOLUNTEERS - THOSE ASSOCIATED WITH REGULAR ORGANIZATIONS
3. SPONTANEOUS ORGANIZATION VOLUNTEERS - THOSE WHO PLACE THEMSELVES AT THE SERVICE OF AN ORGANIZATION. THESE MAY BE ASSOCIATED WITH THE FOUR TYPES OF ORGANIZATIONS.
4. ANTICIPATED INDIVIDUAL VOLUNTEERS - THOSE WHO FULFILL THE GENERAL EXPECTATIONS OF SOCIETY ON AN INDIVIDUAL BASIS.

Figure 96 - A Typology of Volunteerism

organizations reflects the continuation of the above motivation. As increasing differentiation occurs the nonvictim roles become less clear and are eventually dissolved.

11. THE DISASTER BEHAVIOR PROFILES - A SPATIAL-TEMPORAL DIFFUSION PROCESS

The preceding profiles provide a systematic sequencing of pre and post-impact behavioral responses. Each illustrates changes in individual and group behavior generated from a disaster event. An evaluation of costs and benefits derived from technological innovation that may change these sequences would be the basis of technological assessment. The changed social behavior by individuals and groups represent responses from the direct impact and its subsequent demands of the disaster agent and response-generated demands by the community to these direct impacts [306]. The relationship of the various sequences to one another illustrates the multiple facets of disaster impacts. The relationship of new technology should be evaluated within the context of the interactions of these sequences.

To facilitate the identification and interaction of the sequences a temporal/spatial data matrix may be constructed. Figure 97 provides a hypothetical format for the data matrix. It may be observed that locations (A, B, C,N) are placed across the top of the table with the time dimension (June 1, 2,Feb. 28) representing the rows of the matrix. Measurements of the profiles would be defined by the columns of the table with each column representing a surrogate measure of organizational or individual behavior. The elements of the matrix would represent scaled magnitudes of the various surrogate measures. It may be noted that the columns have been subdivided into direct and indirect measures of the behavioral profiles. Direct surrogate measures of the behavioral profiles would represent the more traditional physical and economic event sequences; while, the indirect would represent surrogate indices of the secondary social, political, and environmental event sequences.

The existence of several locations and time periods places the data within a diffusion context. Hence, direct impacts of location A will occur prior to their appearance at location B, location C, etc. Each profile may be perceived as a wave which expands over space through time. The primary impacts (the direct impacts) would be prevalent in the initial post-impact periods, while the secondary (indirect impacts) would follow and become dominant in the latter stages of the temporal continuum.

An evaluation of the cost/benefit of the disaster must incorporate sufficient sensitivity over time and space to identify not only the primary impacts but also the secondary diffusion waves. The advent of new technology and its impact should be sufficiently sensitive to isolate the multiple diffusion waves and the alterations that the new technology would induce in these waves.

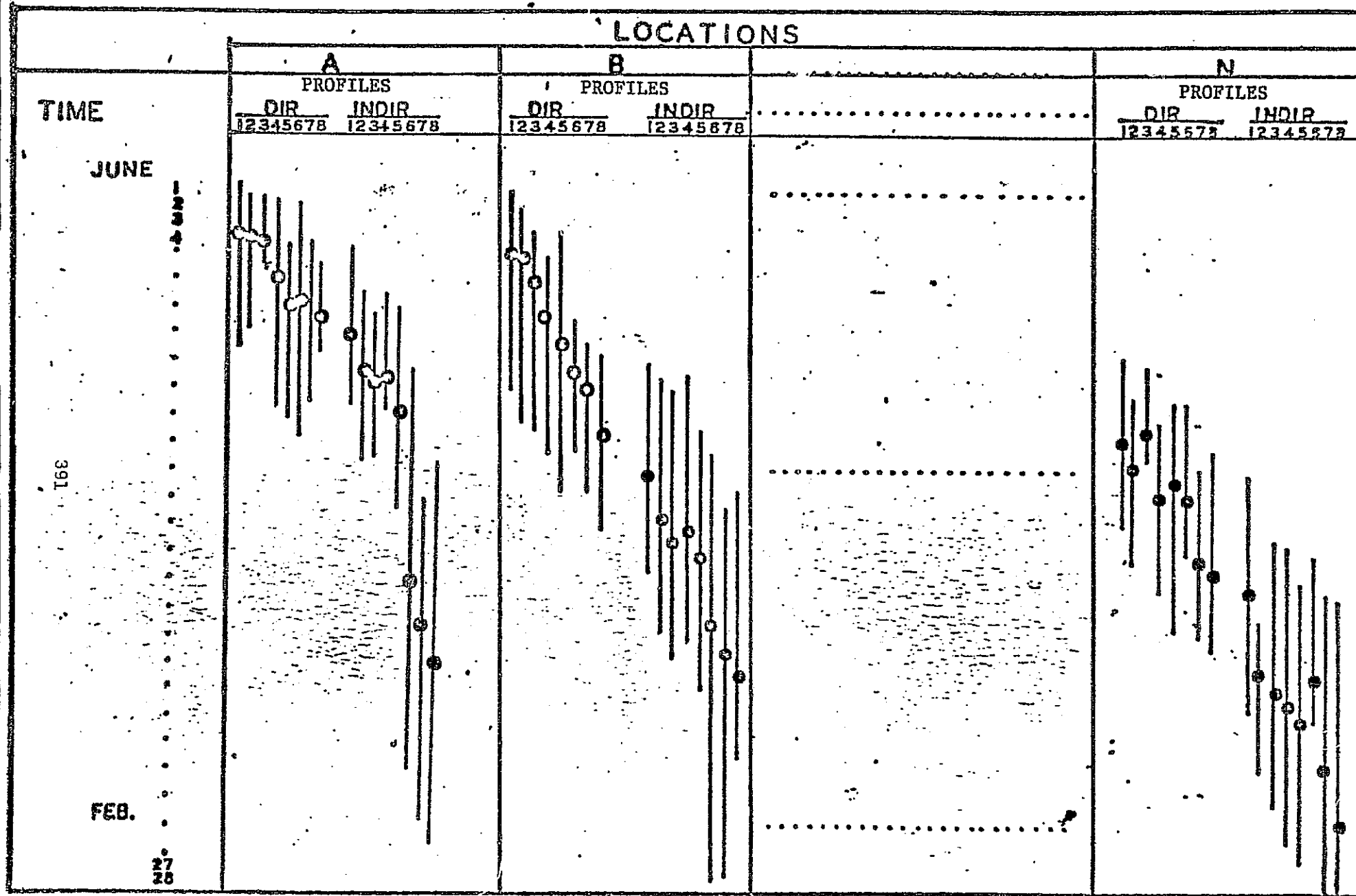


Figure 97 - The Spatial-Temporal Data Matrix

12. AN APPLICATION OF THE PROFILE SEQUENCING MECHANISM

To verify the preceding sequences and their implications to one another a content analysis has been employed. This analysis was designed to link the data resulting from the Agnes disaster with the social action theory then being developed for TAP. As developed by King [331,332] and by Muraco [333], social action theory is the core of the Total Assessment Profile. Among its other principles, it posits that "men seek values through institutions utilizing resources". [332] This phrase implies a hierarchical chain of concepts that begins with what people believe (values) and culminates with the social institutions that are created to attain those ends. Behavior within this continuum varies greatly among individual role-holders who, when aggregated according to similarities, constitute phenotypes. Phenotypes are defined and identified by the interaction between the demographic and social-psychological traits that people manifest. Changes in phenotypic behavior can be analyzed both spatially and temporally. Social action theory has been developed extensively elsewhere in these working papers.

Early in the development of the Total Assessment Profile it became apparent that certain important relationships would have to be measured empirically if it was to be credible. Especially important among these relationships were the various components of social cost and of damaged assets. Nine major categories of general content variables were stipulated, and each of these was subdivided in from two to nine parts. Each of these forty-four concepts proved amenable to meaningful analysis, with the possible exception of the three Time Element indicators and the two indicators of Systemic Locus of Perception. The categories and their subdivisions are presented in Table 10.

Table 10

General Content Analytic Categories

Categories	Percent of Articles in Which Mentioned (N = 190)
<u>TIME ELEMENT</u>	
RETROSPECTIVE PERCEPTION	99
CURRENT PERCEPTION	83
FUTURE PERCEPTION	64

THEMATIC PERCEPTIONS (CONTINUED)

SYSTEMIC LOCUS OF PERCEPTION

EXTRASYSTEMIC	93
INTRASYSTEMIC	80

AREAL LOCUS OF PERCEPTION

METROPOLITAN	90
STATE	72
REGIONAL	48
EXTRAREGIONAL	36

DAMAGE CAUSES

FLOOD	86
GENERAL STORM DAMAGE	61
RAIN	25
WIND	8
FIRE	4

GOVERNMENTAL REFERENCES

FEDERAL	74
STATE	36
LOCAL	30

ORGANIZATIONAL REFERENCES

PRIVATE INDIVIDUALS	78
BUSINESS	64
EMERGENT VOLUNTEER GROUPS	22
ESTABLISHED VOLUNTEER GROUPS	19
LABOR UNIONS	3

DAMAGED ASSETS

RESIDENTIAL	45
BUSINESS	44
UNSPECIFIED GENERAL	37
COMMUNICATIONS	31
ECOLOGICAL	28
DEATH, DISEASE AND INJURY	21
AESTHETIC	16
SOCIAL PSYCHOLOGICAL	12
AGRICULTURAL	11

THEMATIC PERCEPTIONS (CONTINUED)

REMEDIAL EFFORTS

MISCELLANEOUS GENERAL	52
FOOD, CLOTHING AND SHELTER	34
LOANS	31
GENERAL REHABILITATION	29
EVACUATION	24
FLOOD INSURANCE	11
TAXES	5
UNEMPLOYMENT ASSISTANCE	3

SOCIAL PHENOMENA

VALUES AND NORMS	92
DISORGANIZATION	66
HASTE	40
COMPLAINTS	36
ALIENATION	13

13. TWO APPROACHES TO OPERATIONALIZATION

The operationalization of social action theory, it was understood early on, would be tentative at best. Originally, it was hoped to sample the whole range of daily newspapers for all cities of more than 100,000 population that were within the four-inch rainfall isohyet of the Agnes storm. This would have involved seventy-six newspapers published within forty Standard Metropolitan Statistical Areas. Limitations of time and of budget, as well as the fact that only a demonstration of the content analysis would be needed for the contract application, caused a reduction in the effort expended within this task. Consequently, only macro-level analysis was performed upon the New York Times for the period from June 15 through December 31, 1972. The Times was selected because it was believed to be more nationally representative of storm coverage than any other single newspaper available, and because its indexing system would facilitate the discovery of all articles relevant to the storm. [334] Only limited credence can be given to information obtained from but a single source, and it can be argued that conscious editorial bias would act as a filter with respect to the news coverage given to damaged areas or to categories of damage. Yet, it seems unlikely that the concepts developed by the social action theory during the Summer of 1974 would have been implemented by reporters or editors acting atheoretically two years before. The chance that the ideas relating to group dynamics, to damage causes, and to remedial efforts, inter alia, would have been presented in so predictive a fashion by the data source must be less than one in twenty.

The first step in content analysis is to identify the number and importance of messages devoted to the subject at hand. [335] During the 200 days of the Agnes sequence, 190 articles pertaining to the disaster were printed in the New York Times. The expectation that a negative skewing of post-disaster reports suggested in the social action theory [333] is borne in Figure 98a. This figure shows a dramatic increase in the number of Agnes-related articles from the second to the tenth days of the period under study. This is followed by a more gradual diminution and levelling off in articles for the balance of the period. Although the articles no longer appear almost daily after the first three months, the storm's effects never were out of the news for more than a week's time --even at $t+190$.

The importance of news articles is more difficult to measure than simply their number. One indicator can be the length of news stories. Figure 98b shows a difference in amplitude of news story length, in comparison with Figure 98a. Once again, however, the dramatic negative skewing is observed. And yet, the articles that do appear after the time of storm impact often are lengthy. A better indicator of article importance is based on Richard Budd's attention score concept [336].

Several difficulties occur with indexes such as this one, and certain decisional rules were formulated to give uniformity to the evaluations: (1) "Published articles" includes any photograph or illustration that is not accompanied by a written story; (2) "Agnes" references that are only aspects of unrelated articles always are given a score of one; (3) four-column headlines subsumed by two two-column separate stories will be counted as a four-column headline for both articles; (4) articles that begin on Page One but that appear primarily on following pages will receive the higher of two scores, where one score results from the Page One computation and the other obtains from the composition of the trailing page. (5) Column widths and typeface sizes occasionally vary from page to page. (No attempt was made to correct for this.) When this modified Budd index is taken as a whole, its reliability problems are more likely to be encountered at the top end of the scale. It is apparent from Figure 98c that the general pattern already seen in Figures 98a and 98b occurs here also, but that it is also a combination of its two predecessors.

14. MEDIAN PUBLICATION DATES

Social action theory posits that different conceptual components of behavior will appear with the passage of time. For example, the first messages observed after a natural disaster would be associated with physical damage. Next in order would be reports on the more immediate secondary costs. Reports of illness and disease would commence after the worst of the disaster impact descriptions had passed. With the passage of time, physical and more immediate secondary costs would diminish, while other categories would rise to take their place. Increases in crimes also might occur. Greatly debilitating disasters, such as Agnes, might work financial

Figure 98a.

Skewness of Three Content Analytic Measures Across

Time: Number of Articles

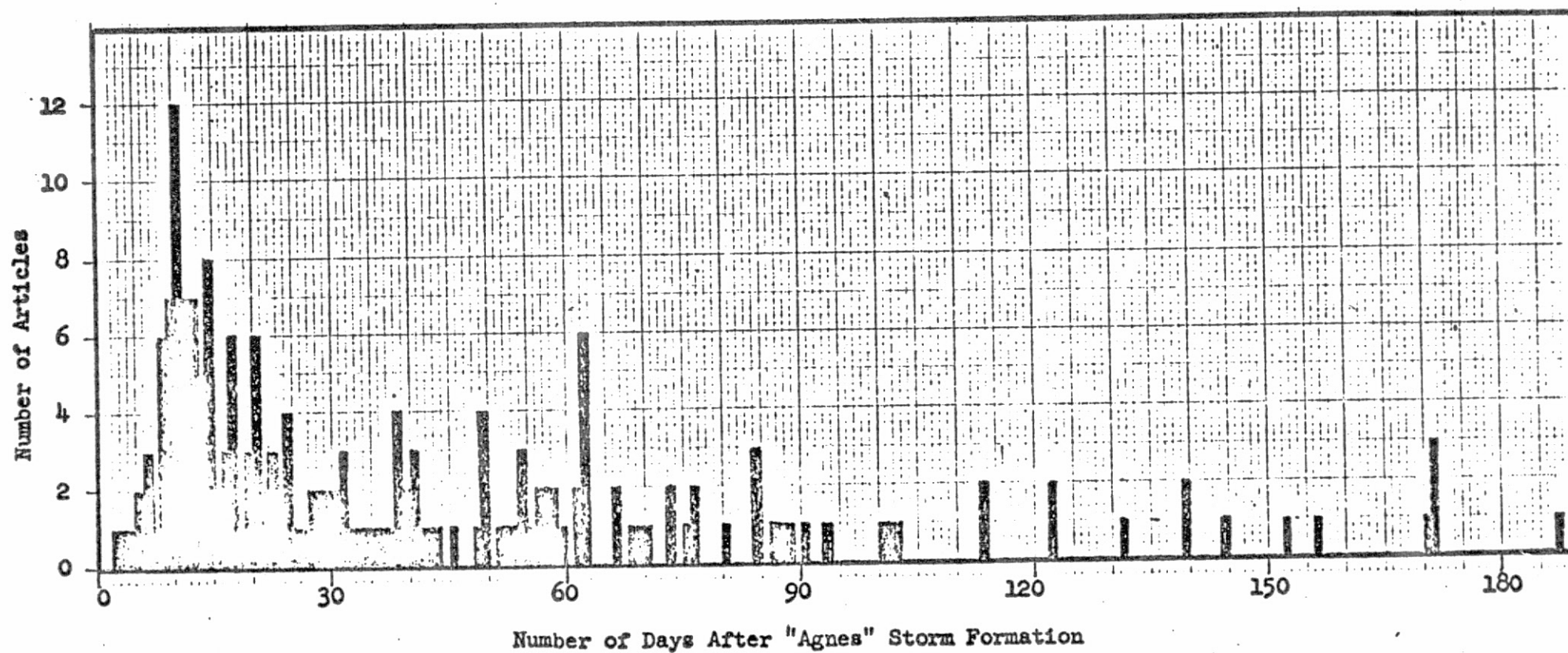


Figure 98a.

Skewness of Three Content Analytic Measures Across

Time: Number of Articles

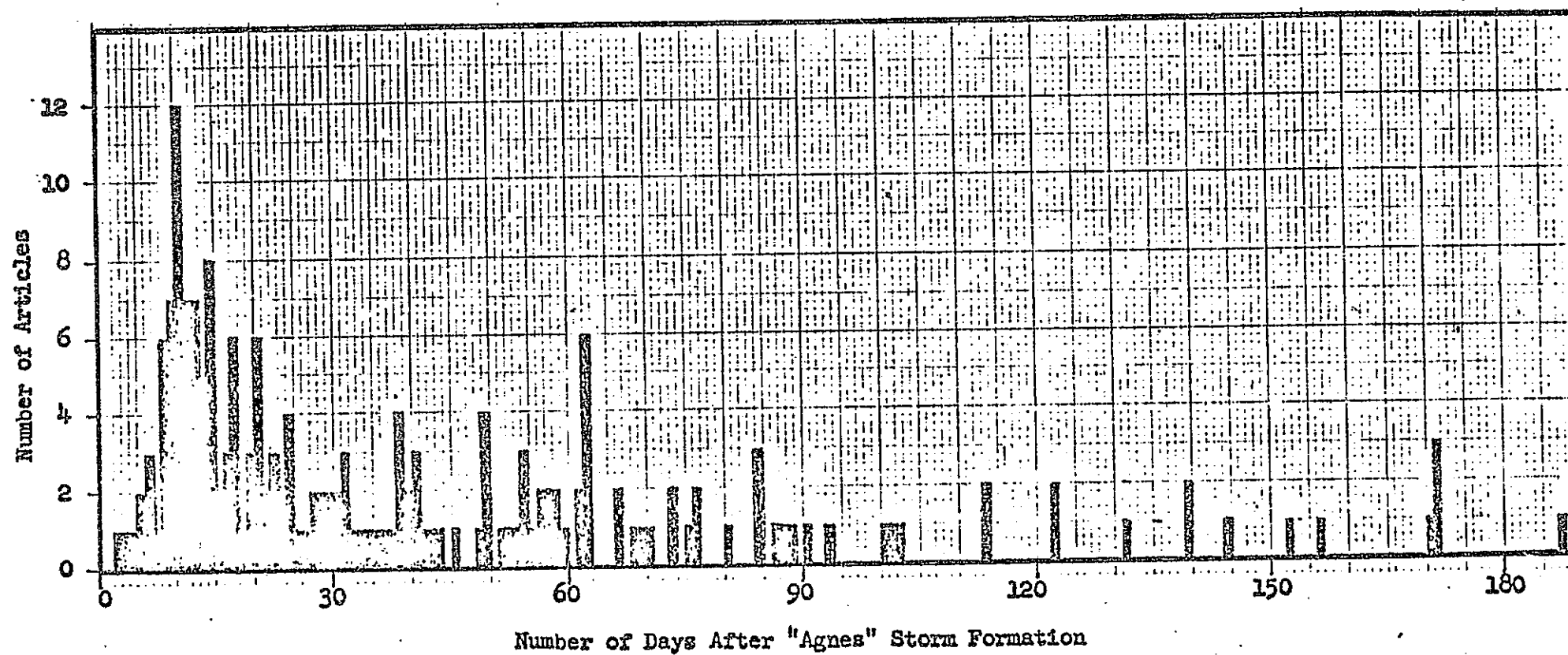


Figure 98b.

Skewness of Three Content Analytic Measures Across

Time: Length of Articles

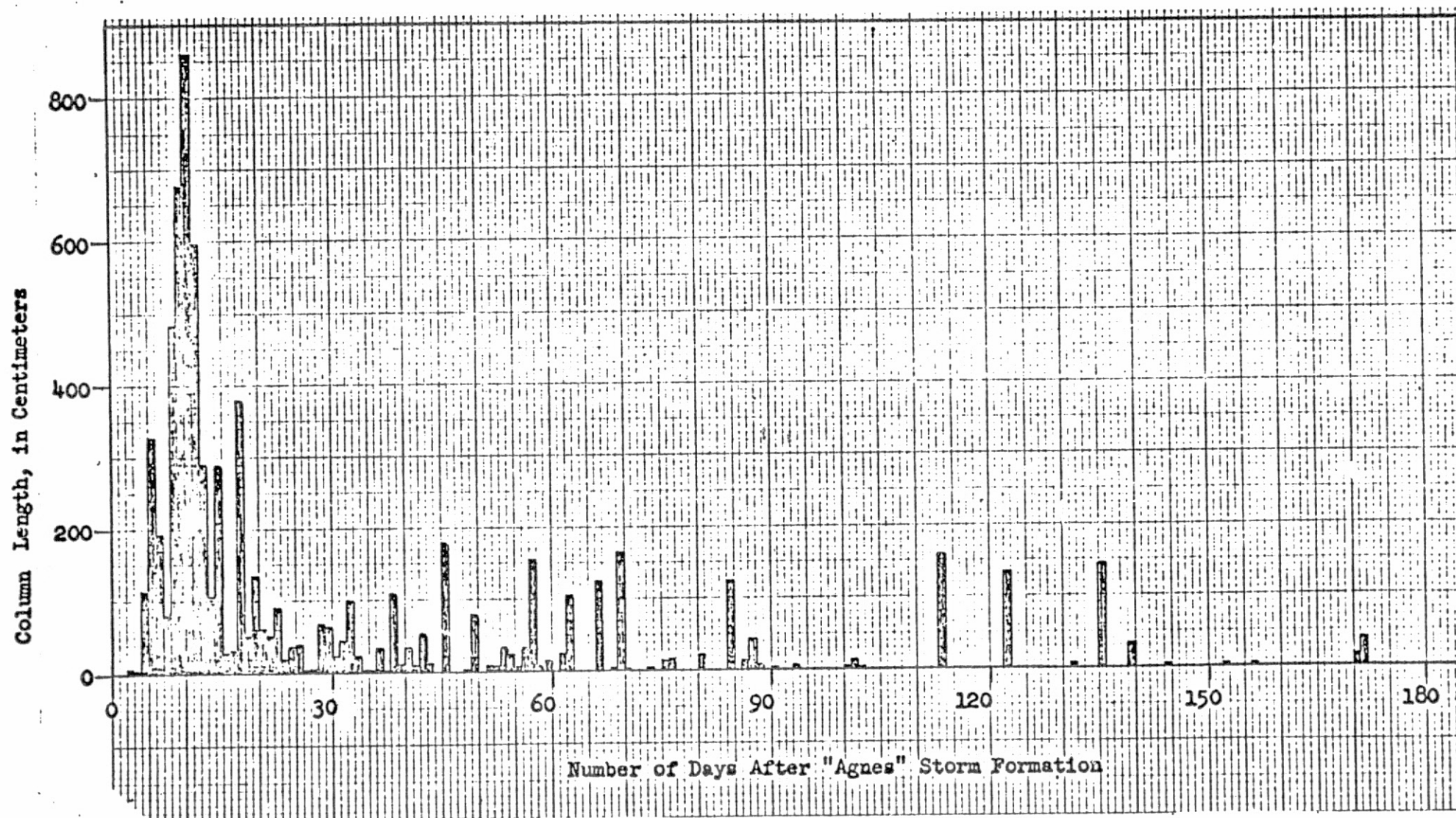


Figure 98b.

Skewness of Three Content Analytic Measures Across

Time: Length of Articles

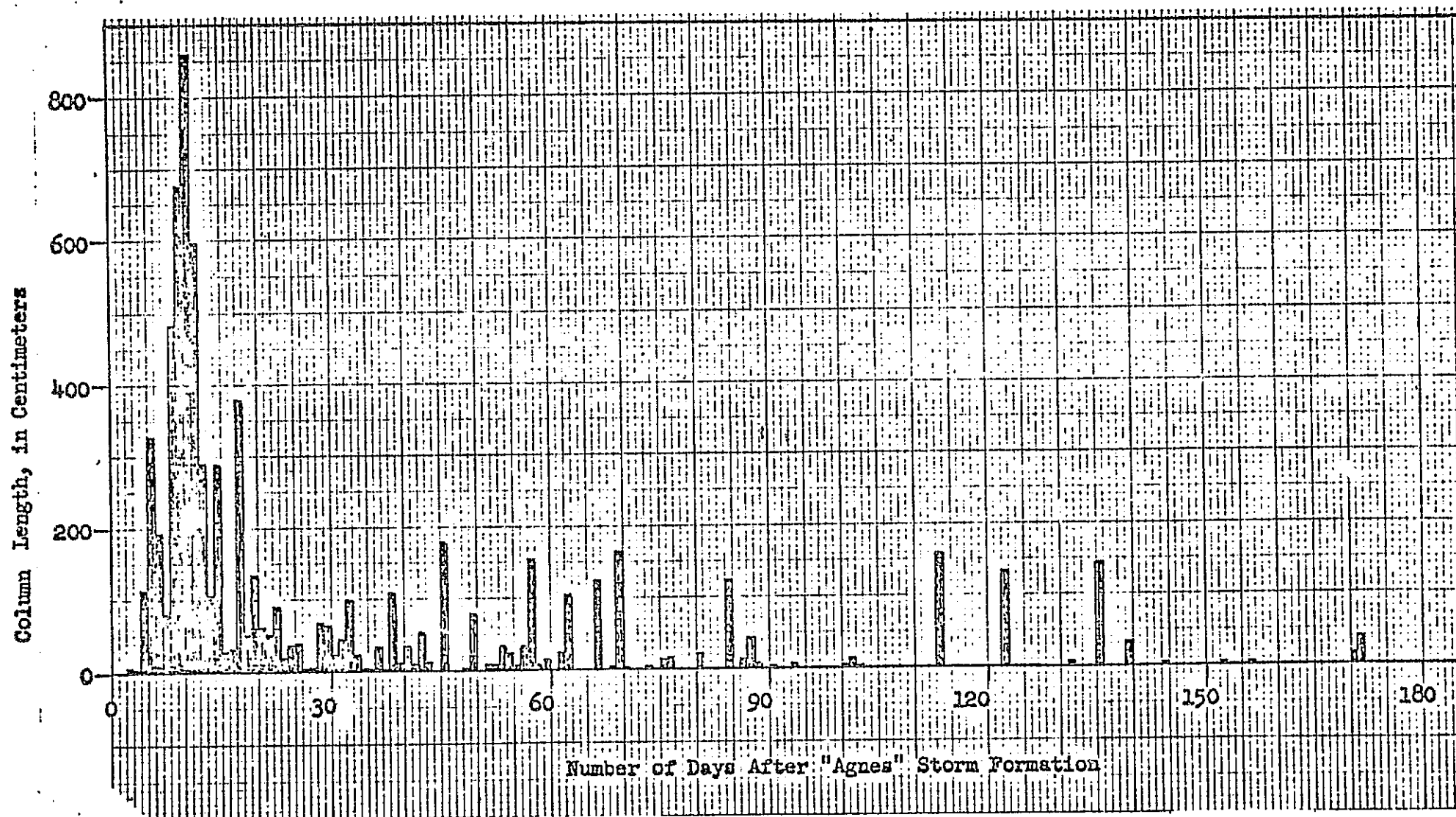


Figure 98c.

Skewness of Three Content Analytic Measures Across

Time: Importance of Articles

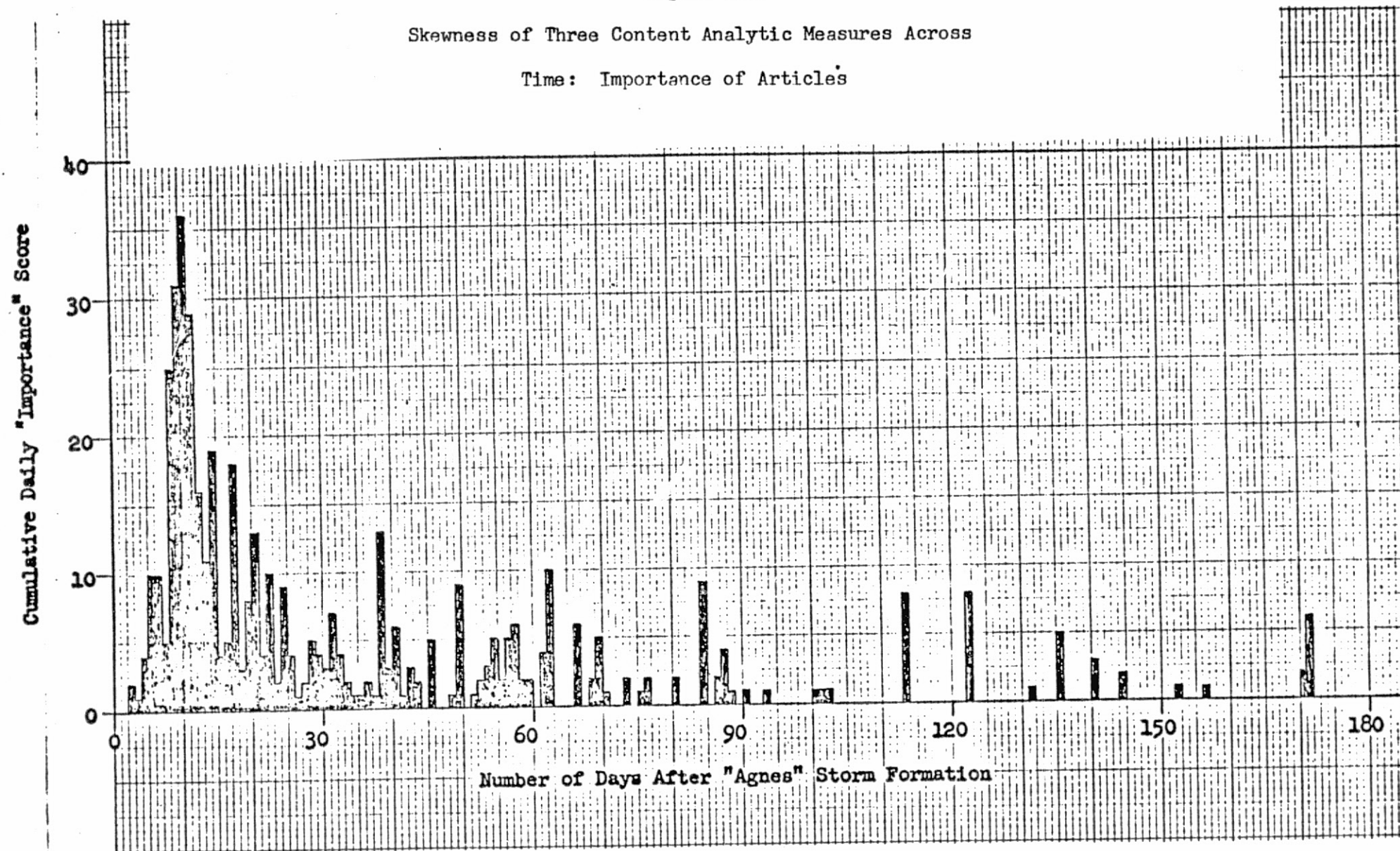
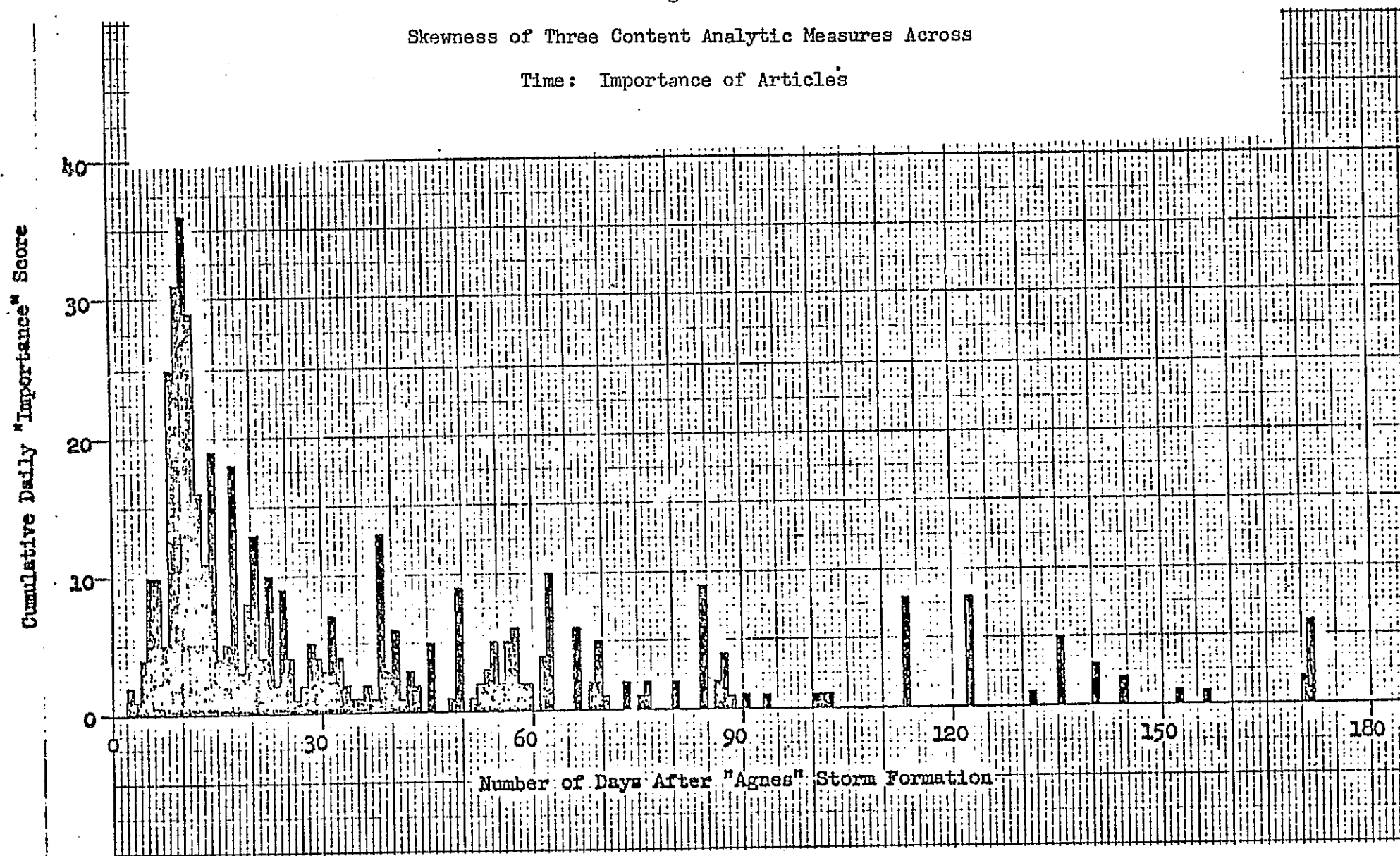


Figure 98c.

Skewness of Three Content Analytic Measures Across

Time: Importance of Articles



hardships that would be felt by families only long after the period of impact has been passed. Perhaps too, as temporal distance from the disaster increases there is a greater threshold value that must be crossed before a secondary cost is deemed newsworthy or is even recognized for what it is. The same might be said spatially, for those living just outside of the officially demarcated impact zone may not qualify for disaster aid. Being without adequate assistance, these areas might witness breakdowns in mental health at a frequency greater than normal. Over an even longer period, divorce rate increases may be incurred as evidence of yet other post-impact costs.

Benefit-cost analysis presumes that there must be debits as well as credits in the evaluation. This is one striking difference between the financial impact of a natural disaster as contrasted with the introduction of a new technology. The former would be expected to offer very few benefits. And yet, increases in community spirit, demolition of grossly sub-standard housing and other social gains can result from natural disasters. Figure 99 suggests the various cost components that social action theory expects to find operating across time in a natural disaster setting.

There are several ways to test whether the wave effects envisioned in social action theory were present in the Agnes disaster. One procedure is to locate the post-disaster day on which the median reference (or "mention") of each category occurred. Those concepts that would be expected to reach a climax early in the scenario would also have earlier median publication dates. Table 11 lists the order in which these "median mentions" occurred. The earliest median, "Wind Damage Causes", was observed at t+7; the last one, "Unemployment Relief Remedies", occurred at t+47.

Table 11

MEDIAN CATEGORY PUBLICATION DATES, NEW YORK TIMES

JUNE 15 -- DECEMBER 31, 1972

WIND DAMAGE CAUSES

FIRE DAMAGE CAUSES

EVACUATION REMEDIES

RAIN DAMAGE CAUSES

ESTABLISHED VOLUNTEER ORGANIZATIONAL REFERENCES

ECOLOGICAL DAMAGES

DEATH, DISEASE AND INJURY DAMAGES

hardships that would be felt by families only long after the period of impact has been passed. Perhaps too, as temporal distance from the disaster increases there is a greater threshold value that must be crossed before a secondary cost is deemed newsworthy or is even recognized for what it is. The same might be said spatially, for those living just outside of the officially demarcated impact zone may not qualify for disaster aid. Being without adequate assistance, these areas might witness breakdowns in mental health at a frequency greater than normal. Over an even longer period, divorce rate increases may be incurred as evidence of yet other post-impact costs.

Benefit-cost analysis presumes that there must be debits as well as credits in the evaluation. This is one striking difference between the financial impact of a natural disaster as contrasted with the introduction of a new technology. The former would be expected to offer very few benefits. And yet, increases in community spirit, demolition of grossly sub-standard housing and other social gains can result from natural disasters. Figure 99 suggests the various cost components that social action theory expects to find operating across time in a natural disaster setting.

There are several ways to test whether the wave effects envisioned in social action theory were present in the Agnes disaster. One procedure is to locate the post-disaster day on which the median reference (or "mention") of each category occurred. Those concepts that would be expected to reach a climax early in the scenario would also have earlier median publication dates. Table 11 lists the order in which these "median mentions" occurred. The earliest median, "Wind Damage Causes", was observed at t+7; the last one, "Unemployment Relief Remedies", occurred at t+47.

Table 11

MEDIAN CATEGORY PUBLICATION DATES, NEW YORK TIMES

JUNE 15 -- DECEMBER 31, 1972

WIND DAMAGE CAUSES

FIRE DAMAGE CAUSES

EVACUATION REMEDIES

RAIN DAMAGE CAUSES

ESTABLISHED VOLUNTEER ORGANIZATIONAL REFERENCES

ECOLOGICAL DAMAGES

DEATH, DISEASE AND INJURY DAMAGES

MEDIAN CATEGORY PUBLICATION DATES (CONTINUED)

COMMUNICATIONS DAMAGES

ALIENATION FEELINGS SOCIAL PHENOMENA

LOCAL GOVERNMENTAL REFERENCES

AESTHETIC DAMAGES

UNSPECIFIED GENERAL DAMAGES

AGRICULTURAL DAMAGES

STATE GOVERNMENTAL REFERENCES

EMERGENT VOLUNTEER ORGANIZATIONAL REFERENCES

FOOD, CLOTHING AND SHELTER REMEDIES

HASTE SOCIAL PHENOMENA

RESIDENTIAL DAMAGES

FINANCIAL LOAN REMEDIES

REGIONAL AREAL LOCALES

FUTURE TIME ELEMENTS

BUSINESS ORGANIZATIONAL REFERENCES

BUSINESS DAMAGES

COMPLAINTS

FLOOD INSURANCE REMEDIES

STATE AREAL LOCALES

GENERAL REHABILITATION REMEDIES

EXTRAREGIONAL AREAL LOCALES

CURRENT TIME ELEMENTS

PRIVATE INDIVIDUAL ORGANIZATIONAL REFERENCES

TAXATION REMEDIES

RETROSPECTIVE TIME ELEMENTS

MEDIAN CATEGORY PUBLICATION DATES (CONTINUED)

EXTRASYSTEMIC LOCUS OF PERCEPTION

FLOOD DAMAGE CAUSES

MISCELLANEOUS GENERAL REMEDIES

DISORGANIZATION PHENOMENA

GENERAL STORM DAMAGE CAUSES

INTRASYSTEMIC LOCUS OF PERCEPTION

METROPOLITAN AREAL LOCALE

FEDERAL GOVERNMENTAL REFERENCES

VALUES AND NORMS

SOCIAL PSYCHOLOGICAL DAMAGES

UNEMPLOYMENT RELIEF REMEDIES

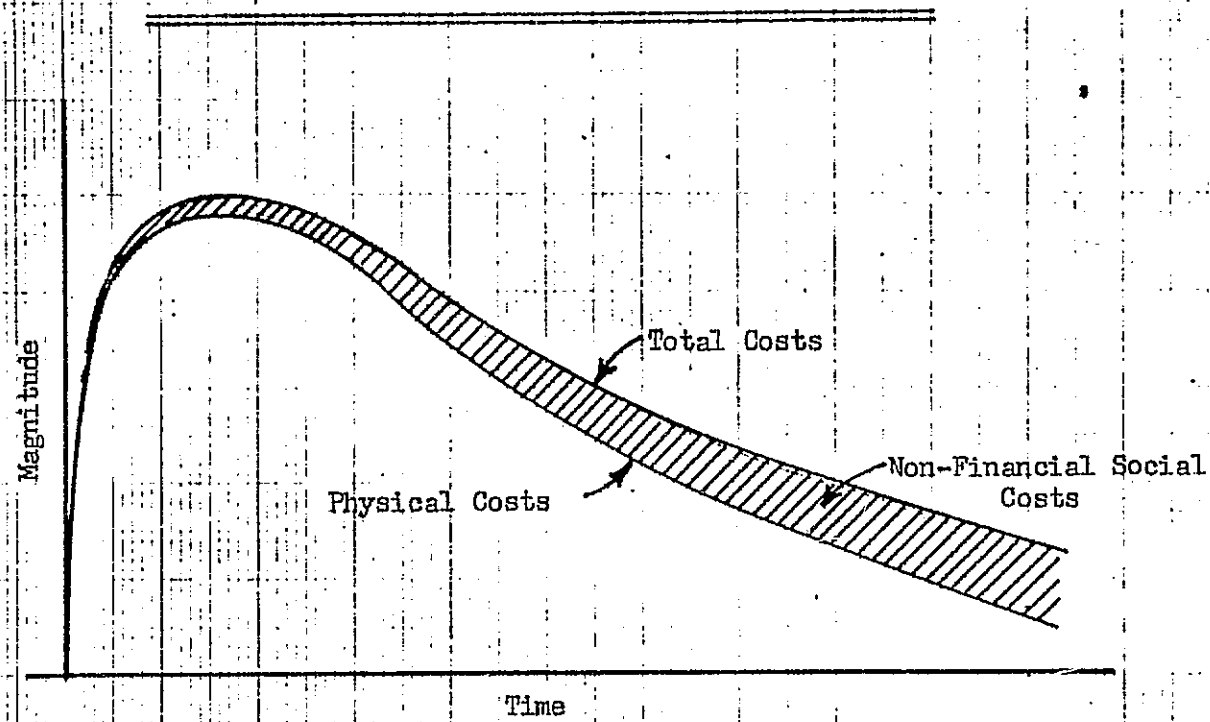
A clearer picture of the ebb and flow of conceptual categories across time comes from their graphic display. Figures 100a through 100d depict this temporal flow. The points represent the median date for articles of a specific subcategory in relation to the temporal dimension.

Most of the categories of behavior associated with the wave effects predicted by social action theory in Figure 99 can be considered using these temporal flow diagrams. Figure 100a shows the median references to causes of damage and to governmental references. Only early in the Agnes reporting were there references to wind, rain, or fire as causes of damage. (Fire damage was a problem in Wilkes-Barre, Pennsylvania, when firefighting services were unavailable during the inundation.) References to the more generalized "flooding", and to unspecified "damages" were part of most later Agnes stories and forced their median reference dates to appear later. It is probable that, with greater distances in time and space from the point of impact, the perceptions of damage causes become less specific.

Figure 100b depicts median references to organizations and to categories of damaged assets. The display shows that references to established volunteer agencies--Red Cross, Volunteers of America, Salvation Army--appeared earlier than those to emergent volunteer groups. Such newly emergent groups tended to consist of ad hoc rescue and salvage parties, neighborhood organizations, and even an employment service to find work for the thousands who were out of work in Western Pennsylvania. It is interesting also that private persons were news subjects later on than

Figure 99

Temporal Sequence of Social Costs



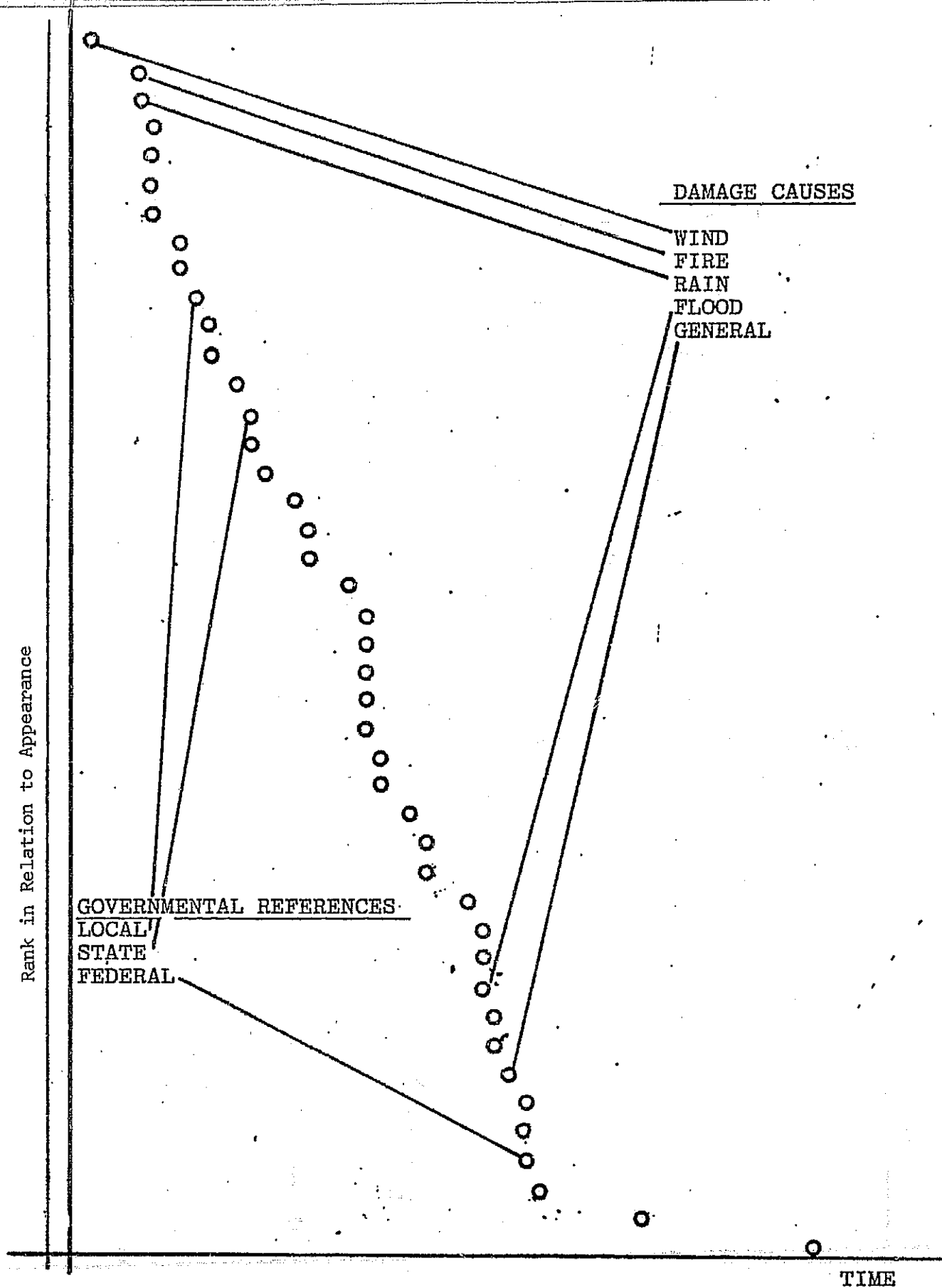


Figure 100a. Content Analysis Medians by Governmental References, and Damage Causes

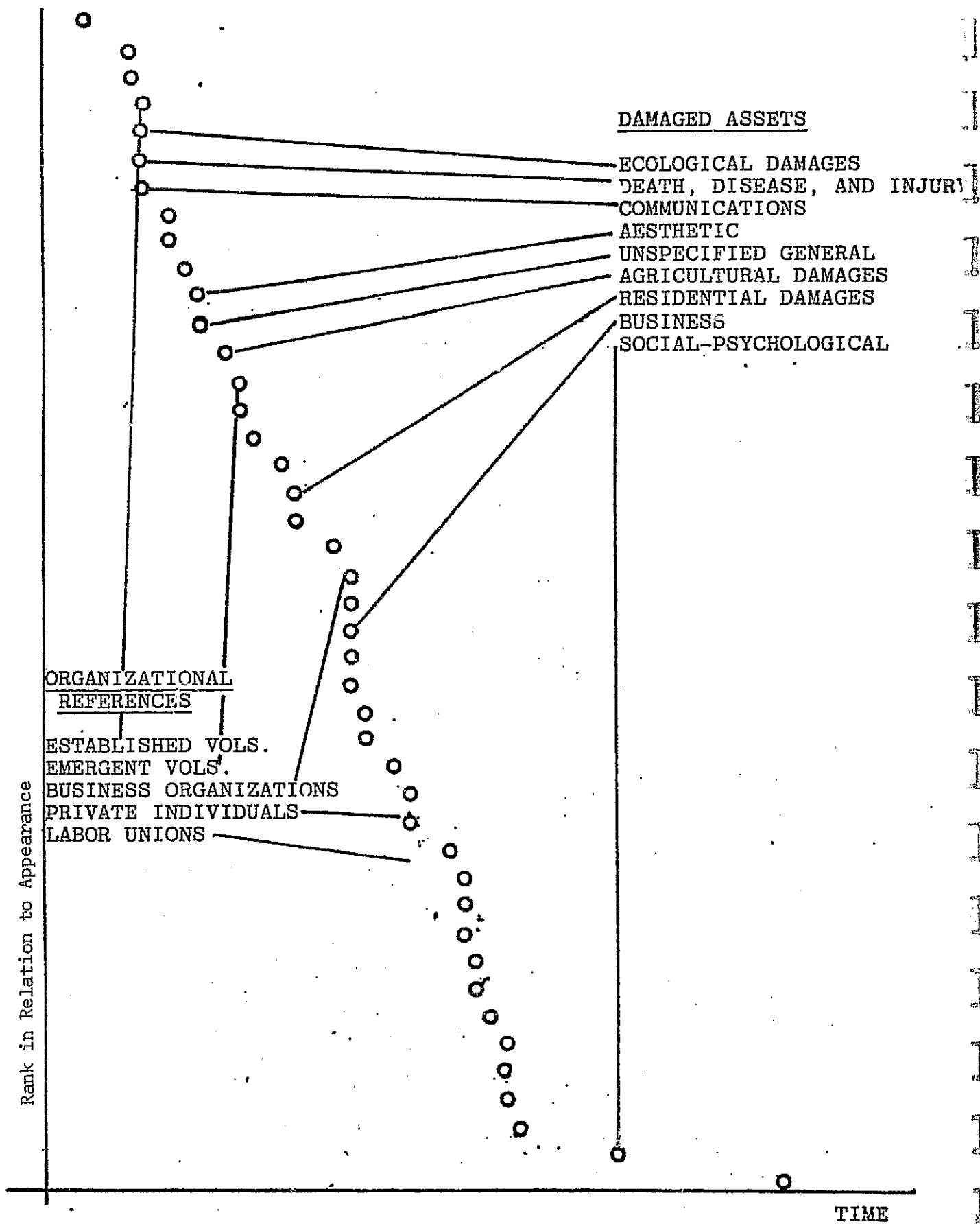


Figure 100b.

Content Analysis Medians by Organizational References,
and by Damaged Assets

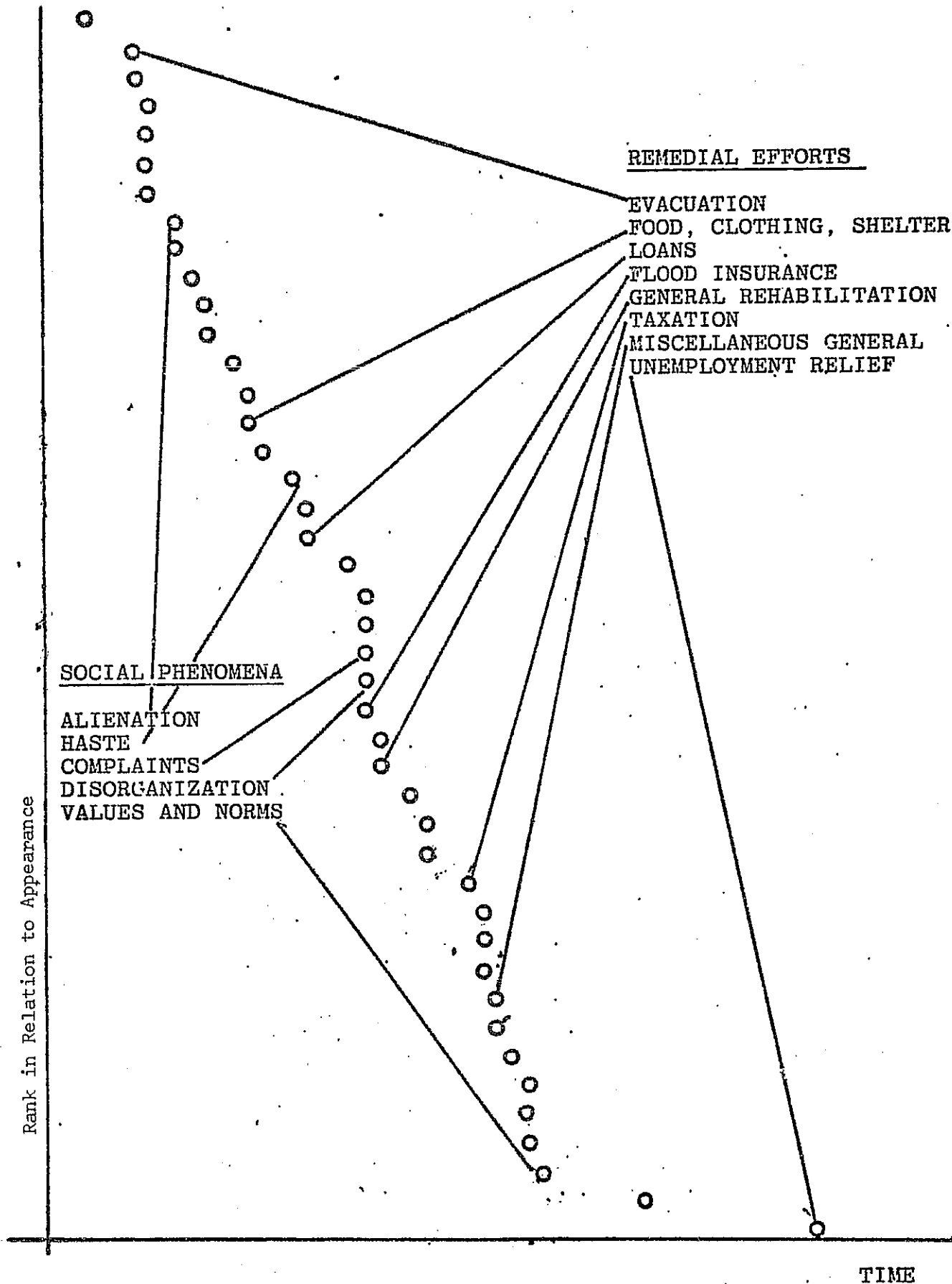


Figure 100c. Content Analysis Medians by Social Phenomena and by Remedial Efforts

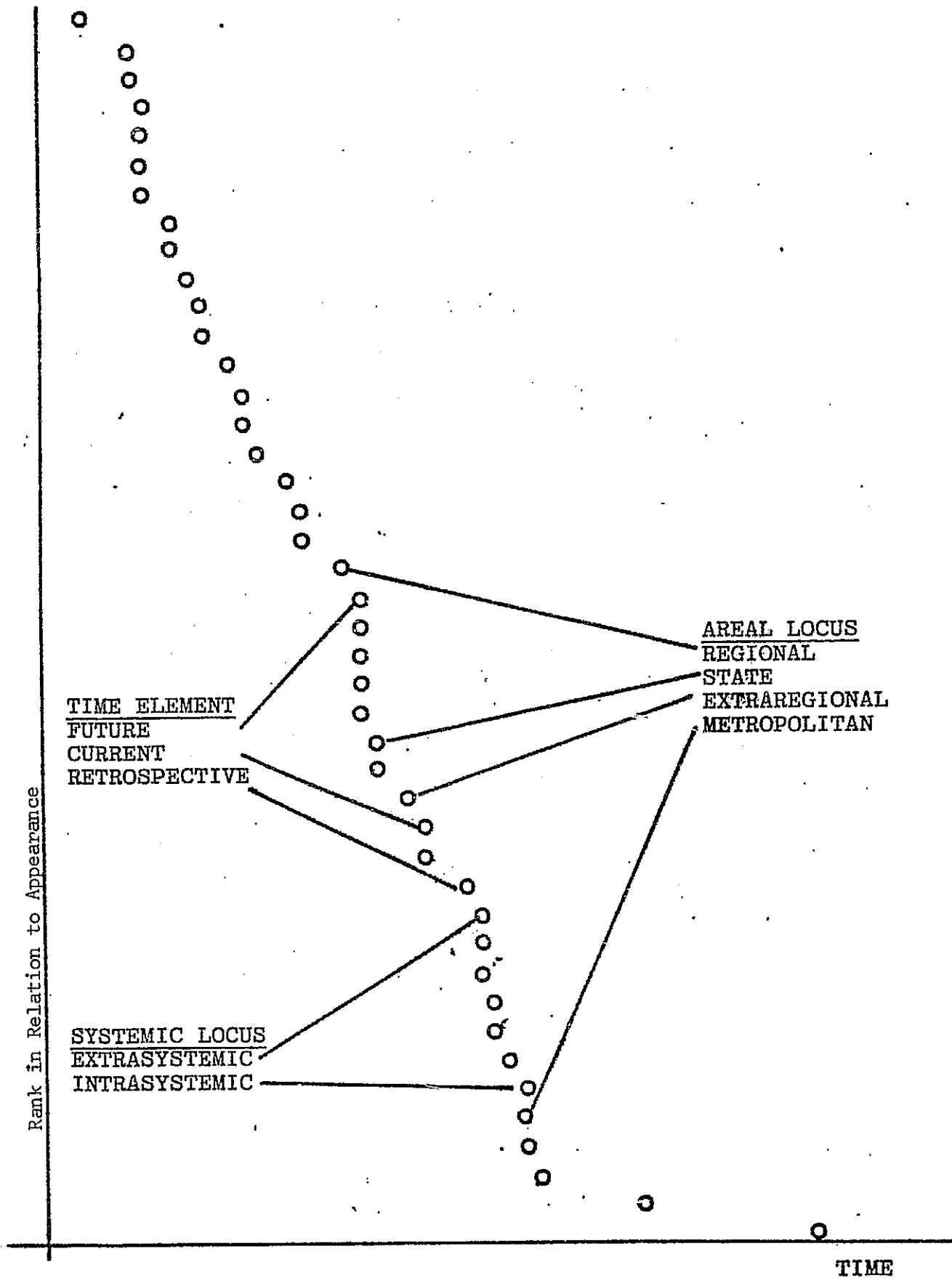


Figure 100d.

Content Analysis Medians by Time Element, Areal Locus, and Systemic Locus Categories

were established businesses. With respect to what was damaged, those categories reported earlier tend to be more tangible things--ecological harm, personal death, disease and injury, highways and telecommunications. Social psychological damages were only recognized sometime later.

Finally, Figure 100c suggests the patterns of miscellaneous social phenomena and remedial efforts. Many of the social variables--complaints, disorganization, values and norms--appear later when the direct presence of outside assistance no longer is noticeable. And here too, with the passage of time the references to remedial efforts becomes less action-oriented and "emergency" in character and take on a more diffuse "general" and "miscellaneous" nature.

15. SLOPE COEFFICIENTS

A more efficient method for assessing trends across time is to use slope coefficients as an index of change. [337,338] A general approach to this is shown in Figure 101. In a two-dimensional graph, let the horizontal dimension represent time (t_0 through t_n) and the vertical axis denote the number of times that each conceptual category is reported. In the figure, X_1Y_1 vsn represent the location of the number of social-psychological "mentions" at $t+i$. Both a later time and a greater number of articles is represented at X_2Y_2 . The slope is simply the change in vertical distance divided by the change in horizontal distance. Therefore,

$$\text{SLOPE} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

Figure 101 depicts an increase in social-psychological mentions across time. If the same number of perceptions were reported later as had been observed before the slope would be horizontal, or would be neutral. A negative slope would depict a decrease in mentions across time.

Linear regression provides a convenient method for the calculation of slope coefficients. As is well-known, it calls for fitting a linear least-squares regression line among a scattering of points in two-dimensional space. The slope of the line is indicated by B and the point at which the line intersects the vertical Y -axis is given as A . Prediction of a given value of Y , given the values of A , B , and of a given value of X follows the familiar equation:

$$Y_p = A + BX$$

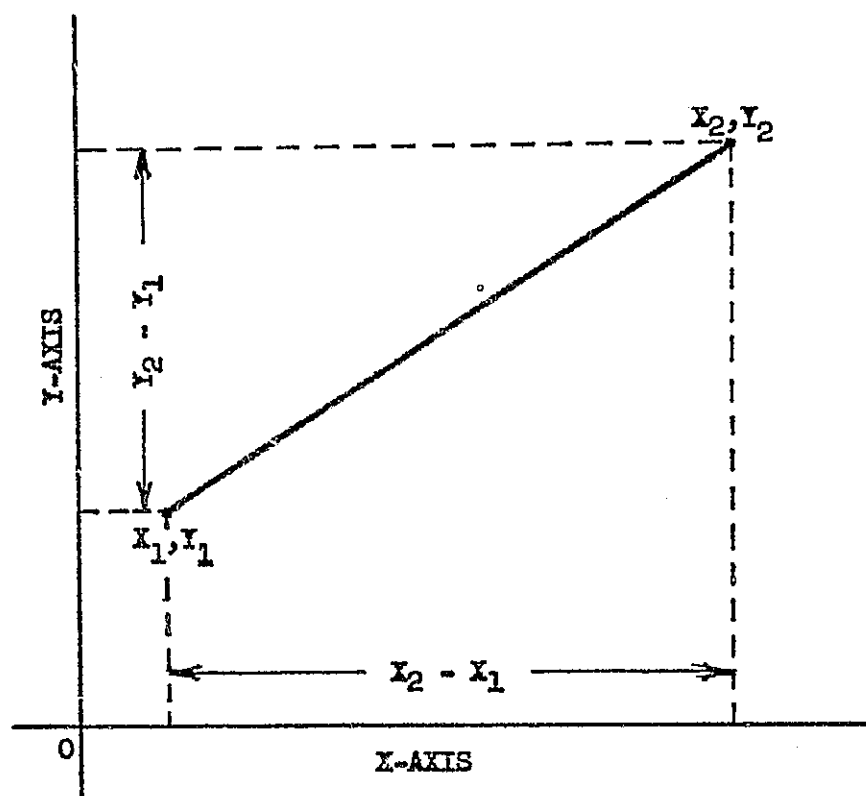
When $B = 1.0$, an increase of one unit of X will yield a one-unit increase in Y . Setting $B = -3.15$ means that an increase of one unit for X will

FIGURE 101.

IDENTIFYING TRENDS WITH SLOPE COEFFICIENTS

(1) CONCEPTUALIZATION

$$\text{SLOPE} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{\Delta \text{ VERTICAL DISTANCE}}{\Delta \text{ HORIZONTAL DISTANCE}}$$



(2) TWO LINEAR REGRESSION SLOPE COEFFICIENTS

BETA = "STANDARDIZED" SLOPE, WHERE X-AXIS VALUES = Y-AXIS VALUES

B = "UNSTANDARDIZED" SLOPE, WHERE X-AXIS VALUES \neq Y-AXIS VALUES

engender a decrease of 3.15 units for Y. When both the X and Y axes are demarcated in identical units (e.g., both represent centimeters) a standardized slope coefficient results. When the X and Y units both have been converted to standard scores (z-scores) the resulting slope coefficient usually is termed Beta. Beta has an advantage over B in that it allows direct comparisons to be made of slope coefficients based upon any X or Y unit of measurement. (Beta always is the same as the product-moment correlation coefficient in the two-variable case.)

Temporal trends in New York Times reporting on the Agnes storm can be identified with B and Beta slope coefficients. Figure 102 shows the models used for establishing positive and negative trends over time for the forty-four content analytic "general" concepts. Because of the relatively small number of cases in most categories and the 200 day time span, the X-axis has been collapsed into three values. The first of these embraces the periods of warning, threat and impact (June 15 - June 27). The second interval is that of rescue and recovery (June 28 - July 9). The longest interval in terms of time encompassed by it is that of remedy and recovery (July 10 - December 31, 1972). The number of times that any category was mentioned was aggregated for each of the three time intervals. The number of times that categories were identified ranged from 188 for Retrospective Perceptions to five for Labor Union References. Both Beta's and B's were computed for each of the forty-four concepts, and they are reported in Table 12.

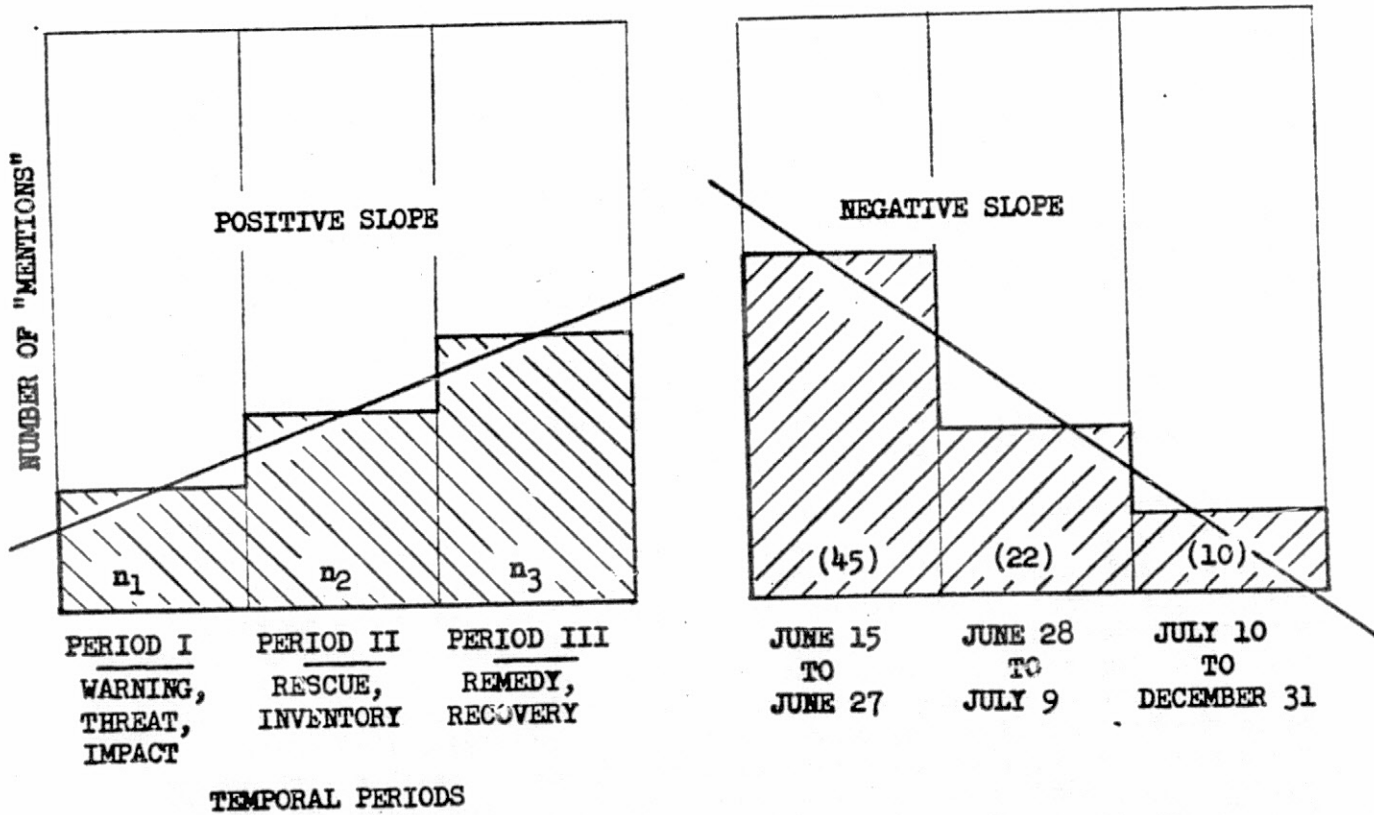
Consider Table 12. First, only about one-fourth of the coefficients are positive. Since only 48 of the 190 New York Times articles bearing upon Agnes appeared during the first of the three periods, 41 during the second, and more than half of them (one-hundred-and-one) during the third interval, how can this happen? The reason is that the earlier pieces were longer and richer conceptually than the later ones. This introduces a predisposition toward negative sloping that suggests that it is more meaningful to make observations on the basis of coefficient rankings than it is to stress specific signs or values.

How does Table 12 relate to social action theory? Some of the signs are positive. The most dramatically increasing trend involves references to values and norms (+.23)--to what should or ought to be attempted in the wake of the storm. These expressions of social preference are markedly more noticeable in the late post-disaster period. References to unemployment also increase with time, just as do passages relating to the Federal government and to social-psychological concepts. When attention is directed to the bottom end of the range the physical categories tend to be encountered (ecological and communicational damage), together with damage causes (rain, wind, fire) and the need to solve the most basic of Maslovian human needs (evacuations, death, disease, injury).

If one relates these slope coefficients with the spatial-temporal data matrix presented earlier (Figure 97) then the observations are seen to be specific to a given location. These same slope patterns would be expected if multiple locations were considered. It would be anticipated that within the context of multiple locations the primary and secondary

FIGURE 102.

MEASURING TEMPORAL TRENDS WITH SLOPE COEFFICIENTS



$(n_1 + n_2 + n_3 = N, \text{ WHERE } N \text{ RANGES FROM } 5 \text{ TO } 188)$

$(45 + 22 + 10 = 77)$

Table 12

SLOPE COEFFICIENTS FOR FORTY-FOUR GENERAL CONTENT VARIABLES

ACROSS THREE POST-DISASTER PERIODS, NEW YORK TIMES, 1972

BETA	B	VARIABLE NAME	BETA	B	VARIABLE NAME
.23	.08	VALUES AND NORMS	-.14	-.05	AGRICULTURAL DAMAGE
.11	.02	LABOR UNION REFERENCES	-.15	-.07	AESTHETIC DAMAGE
.07	.02	UNEMPLOYMENT REFERENCES	-.16	-.10	HASTE
.06	.02	EXTRASYSTEMIC PERCEPTION	-.17	-.10	FOOD, CLOTHING, SHELTER
.05	.03	MISCELLANEOUS RELIEF	-.18	-.11	REGIONAL LOCALE
.05	.02	METROPOLITAN LOCALE	-.19	-.12	BUSINESS DAMAGE
.04	.02	FEDERAL GOVT. REFERENCES	-.20	-.08	ALIENATION FEELINGS
.02	.01	SOCIAL PSYCHOLOGICAL COSTS	-.21	-.11	EMERGENT VOLUNTEERS
.02	.01	DISORGANIZATION REFERENCES	-.22	-.13	STATE GOVT. REFERENCES
.02	.00	RETROSPECTIVE PERCEPTION	-.22	-.14	RESIDENTIAL DAMAGE
.01	.00	TAX RELIEF	-.23	-.13	STATE LOCALE
-.01	-.01	COMPLAINTS	-.23	-.14	BUSINESS REFERENCES
-.02	-.01	GENERAL REBUILDING	-.26	-.16	UNSPECIFIED GEN. DAMAGES
-.02	-.01	INTRASYSTEMIC PERCEPTION	-.29	-.14	ESTABLISHED VOLUNTEERS
-.03	-.01	FLOOD INSURANCE	-.31	-.08	FIRE DAMAGE
-.04	-.02	EXTRAREGIONAL LOCALE	-.34	-.17	DEATH, DISEASE AND INJURY
-.04	-.03	GENERAL STORM DAMAGE	-.35	-.12	WIND DAMAGE
-.07	-.03	FLOOD DAMAGE	-.35	-.20	LOCAL G. F. REFERENCES
-.09	-.05	PVT CITIZEN RELIEF	-.38	-.22	COMMUNICATIONS DAMAGES
-.10	-.06	LOANS	-.41	-.22	EVACUATIONS
-.10	-.06	FUTURE PERCEPTIONS	-.44	-.24	RAIN DAMAGE
-.11	-.05	CURRENT PERCEPTIONS	-.48	-.27	ECOLOGICAL DAMAGE

*T1 = WARNING, THREAT, IMPACT, JUNE 15 - 27; T2 = RESCUE, INVENTORY, JUNE 28 - JULY 9; T3 = REMEDY, RECOVERY, JULY 10 - DECEMBER 31. N's FOR EACH PERIOD ARE 48, 61 and 81, RESPECTIVELY.

impacts would reflect a staggered pattern over time and space. The staggering of the sequences would indicate the frictional impacts of distance as primary and secondary waves diffuse over the surface. As the number of multiple locations experiencing the events increases the cost implications of that event would also be growing. Those costs observed at one location would then be multiplied over the entire surface as the event is diffused.

16. SEQUENTIAL RELATIONSHIPS IN THE DISASTER PROFILE SEQUENCES

One of the fore mentioned objectives of this paper was to define the sequential relationships of behavior associated with the impact of a disaster. Utilizing the preceding data matrix (Figure 97) as a structural device a cross impact analysis may be undertaken. Table 13 provides a listing of major behavioral sequences observed earlier in the paper. Four major categories are presented in the figure: community functions, organizational functions, communications functions, and individual functions. Employing the thematic subcategories of the content analysis surrogate measures of the sequential functions may be demonstrated.

To define the degree of association between the surrogate measures of sequential functions phi coefficients were employed. A phi coefficient greater than + or - .20 was considered to represent the existence of a relationship (Table 14). To enhance ease of interpretation of the relationships between the surrogate indices the phi correlation table was transformed to a nominal scale and presented as a connection matrix in Table 15. A cell, in the connection matrix, containing a one may be considered to have a significant linkage (greater than $\pm .20$) with a zero element reflecting the absence of a linkage or relationship. The relationships indicated by the patterns within the connection matrix suggest the complex linkages between the sequential functions. Several subgroup linkage clusters appear within the connection matrix. For example, organizational functions reflect a "neighborhood influence" focusing on the diagonal of the matrix. A somewhat weaker, but still apparent, intra-linkage cluster appears for the community function and individual function surrogate measures. Relatively strong inter-group linkages appear between organizational measures, the community function variables, and the individual function variables.

A topological presentation of the above connection matrix is presented as a di-graph in Figure 103. The high degree of intra-group interaction is clearly demonstrated within the community function and organizational surrogate measures. The inter-group interactions appear to center on both the communications and organizational measures. An analysis of the costs and benefits that may be derived from a new technological innovation would necessitate an evaluation of the above linkages. It is the interactions of these linkages and their resulting modifications in the behavioral sequences which determines the true values or costs associated with the technological input. If the disaster warning system would intensify stress for a society, considerable primary and secondary costs may be anticipated.

FUNCTIONS	GENERAL FUNCTION CATEGORIES	SURROGATE MEASURES
Production, Distribution, Consumption		Food, Clothing, Shelter Loans
Socialization	Community Functions	Unemployment
Social Participation		Flood Insurance
Social Control		Ag. Damage
Mutual Support		General Storm Damage Damage to Business
Type 1 - Established	Organizational Functions	Private Groups
Type 2 - Expanding		Ongoing Volt. Groups
Type 3 - Extending		Emergent Groups
Type 4 - Emergent		Federal Govt. State Govt. Local Govt.
Detection	Sender Functions	
Prediction		Communication References
Dissemination	Communication Functions	Intra-Systemic
Evaluation		Extra-Systemic
Reinforcement	Receiver Functions	
Natural Event Modifications		Social-Psychological Alienation
Human Use Modifications	Individual Functions	Values and Norms
Victim/Nonvictim Behavior		Disorganization
		Death, Disease, Injury
		Current Perception Retrospective Perception Future Perception

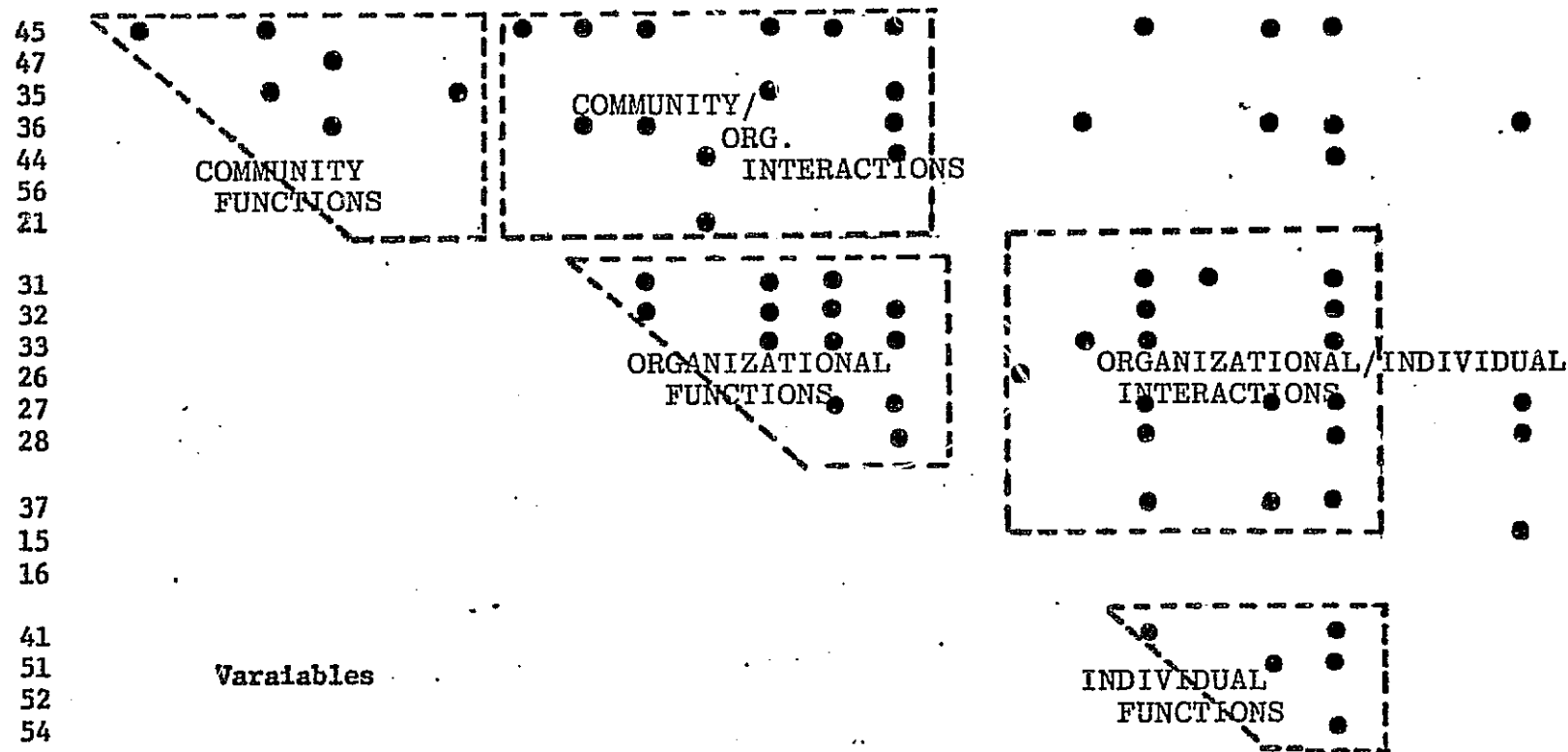
Table 13 - Generalized Behavior Sequence Functions and their Associated Surrogate Measures

Variables:																							Variables	
45	47	35	36	44	56	21	31	32	33	26	27	28	37	15	16	41	51	52	54	39	12	13	14	
45	.25	.08	.29	.11	.07	.14	.38	.39	.32	.15	.28	.35	.42	.11	.12	.16	.25	.06	.32	.35	.15	.07	.09	45 Food, Clothing, Shelter
47		.04	.14	.21	.06	.08	.02	.06	.05	.11	.05	.08	.20	.09	.05	.12	.02	.05	.07	.06	.08	.02	.13	47 Unemployment
35			.22	.15	.06	.29	.10	.14	.02	.17	.24	.08	.21	.09	.10	.07	.02	.02	.17	.12	.02	.04	.04	35 Ag. Damage
36				.20	.06	.16	.06	.20	.20	.07	.18	.13	.51	.18	.04	.21	.16	.11	.29	.39	.07	.01	.23	36 Damage to Business
44					.17	.08	.19	.06	.05	.34	.05	.05	.20	.01	.19	.01	.11	.16	.09	.20	.12	.07	.09	44 Loans
56						.14	.15	.13	.07	.06	.02	.10	.02	.10	.03	.08	.16	.11	.05	.01	.07	.04	.19	56 Flood Insurance
21							.02	.06	.04	.26	.15	.18	.16	.08	.02	.02	.01	.03	.09	.11	.03	.02	.17	21 General Storm Damage
31								.16		.17	.21	.21	.14	.07	.14	.19	.21	.20	.13	.27	.12	.05	.01	31 Private Groups
32									.29	.02	.31	.25	.34	.08	.03	.08	.21	.01	.17	.32	.12	.05	.11	32 Ongoing Volt. Groups
33										.14	.21	.24	.25	.08	.04	.20	.39	.12	.22	.33	.11	.07	.11	33 Emergent Groups
26											.05	.10	.01	.07	.29	.01	.02	.16	.02	.16	.14	.06	.02	26 Federal Govt.
27												.38	.35	.11	.13	.01	.26	.05	.28	.33	.08	.08	.26	27 State Govt.
28													.24	.13	.05	.16	.26	.03	.09	.34	.02	.07	.22	28 Local Govt.
37														.17	.06	.08	.24	.04	.29	.42	.07	.07	.15	37 Communications
15															.14	.10	.08	.17	.19	.03	.08	.08	.22	15 Intra-Systemic
16																.02	.05	.01	.03	.09	.14	.17	.04	16 Extra-Systemic
41																	.30	.05	.15	.26	.12	.04	.03	41 Social-Psychological
51																		.12	.21	.22	.14	.04	.19	51 Alienation
52																			.06	.03	.01	.03	.01	52 Values and Norms
54																				.20	.14	.04	.10	54 Disorganization
39																					.06	.05	.11	39 Death, Disease, Injury
12																						.05	.21	12 Current Perception
13																							.14	13 Retrospective
14																								14 Future Perception

Table 14 - Table of Phi Coefficients for the Surrogate Measures of Sequence Functions

Variables:

45 47 35 36 44 56 21 31 32 33 26 27 28 37 15 16 41 51 52 54 39 12 13 14



Variables

45 Food, Clothing, Shelter
47 Unemployment
35 Ag. Damage
36 Damage to Business
44 Loans
56 Flood Insurance
21 General Storm Damage

31 Private Groups
32 Ongoing Volt. Groups
33 Emergent Groups
26 Federal Govt.
27 State Govt.
28 Local Govt.
37 Communications
15 Intra-Systemic
16 Extra-Systemic

41 Social-Psychological
51 Alienation
52 Values and Norms
54 Disorganization
39 Death, Disease, Injury
12 Current Perception
13 Retrospective
14 Future Perception

Table 15 - Sequence Functions Connection Matrix for Phi Coefficients
Greater Than .20+

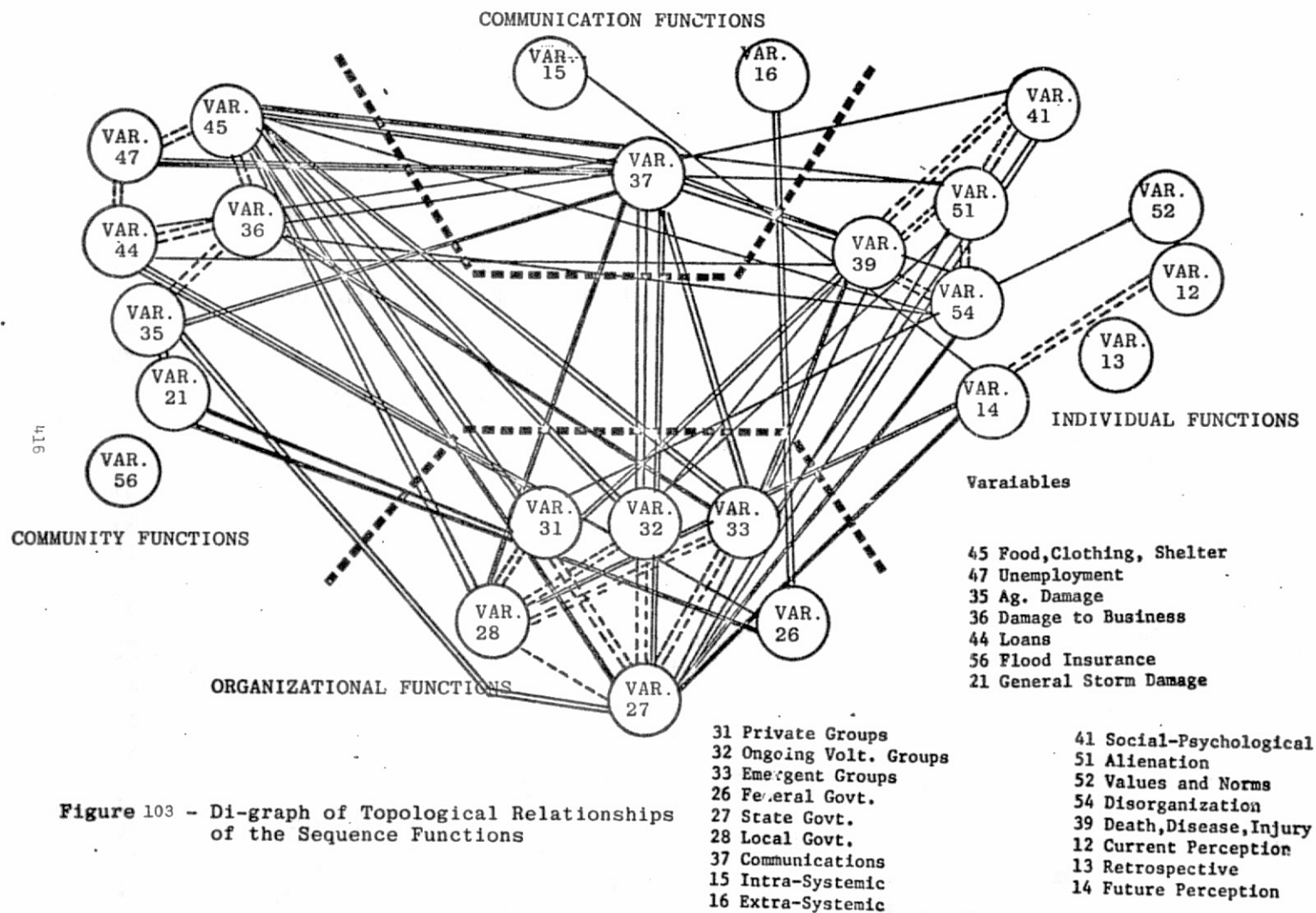


Figure 103 - Di-graph of Topological Relationships of the Sequence Functions

Those linkage intersections which generate conflict or stress for a society should be recognized and considered a normative direction in which technology may be oriented.

The previous linkage analysis has identified key interaction dyads that may be evaluated in regard to an early warning technology system. Figure 104 identifies the key dyads and the potential impact that the early warning system may have on them. It should be pointed out that this is a demonstration and that the actual scaled impacts are proposed to be determined through a survey instrument applied to both a cross-sectional sample of the potential population and through the utilization of a delphi panel approach. Nevertheless, Figure 104 provides the identification of a profile that may be anticipated from the interaction linkages and the warning satellite.

Examination of Figure 104 reveals numerous duplications and serious difficulties in quantification of the potential impact of an early warning technology. In most cases, the dyads represent the interactions of the new technology with values, norms, and institutions of a society.

17. ATHEORETICAL CONCERNS: QUALITY OF LIFE

Although this content analysis was performed to operationalize elements of social action theory, a recent development in social science warranted following an atheoretical tack as well. This development was a published report on developing a quality of life index. For years planners have sought to identify the fundamental components of a lifestyle. Ideally, the decisions of business and government should enhance the quality of life, and not detract from it. Yet, lacking a yardstick for assessing its components, this is a goal that has proven elusive. Researchers at the Institute for Social Research assembled a ten-item quality of life scale. Based upon interviews with Federal governmental officials, the components of the index are (1) health, (2) quality of work, (3) attitudes toward government, (4) education, (5) environmental quality, (6) crime, (7) leisure and recreation, (8) living conditions, (9) racial and minority group relations and (10) transportation. [339] Although little is known about the independence of these categories from one another, these variables seem worthy of consideration for any assessment of a natural disaster's impact upon society.

Just as with the "general" content analysis categories, the ten quality of life components were encoded simply as "mentioned" or "not mentioned". The time dimension was trichotomized as before, and slope coefficients were computed. The results are shown in Table 16.

The fewer number of concepts reported in Figure 102 make it easy to summarize. The strongest positive slope is that of Education. Here, the news references often were to educational facilities that were damaged or destroyed in the flooding, and to efforts to rehabilitate these services.

Communication Technology

Community Functions:

Food/Unemployment
Food/Damage to Business
Food/Pvt. Groups
Food/Volt. Groups
Food/Emergent Groups
Food/State Govt.
Food/Local Govt.
Food/Communications
Food/Alienation
Food/Death, Disease, Injury
Unemployment/Loans
Ag. Damage/Damage to Business
Ag. Damage/General Storm Damage
Ag. Damage/Communications
Damage to Business/Loans
Damage to Business/Volt. Group
Damage to Business/Emergent Volt. Group
Damage to Business/Communications
Damage to Business/Social Psychology
Damage to Business/Disorganization
Damage to Business/Death, Disease, Injury
Damage to Business/Future
Loans/Federal Government
Loans/Communications
Loans/Death, Disease, Injury
Loans/General Storm Damage

Organizational Functions:

Pvt. Group/Emergent Groups
Pvt. Groups/State Govt.
Pvt. Groups/Local Govt.
Pvt. Groups/Alienation
Pvt. Groups/Values and Norms
Pvt. Groups/Death,Disease, Injury
Ongoing Volt/Emergent Groups
Ongoing Volt./State Govt.
Ongoing Volt./Local Govt.
Ongoing Volt./Communications
Ongoing Volt./Alienation
Ongoing Volt./Death,Disease, Injury
Emergent Group/State Govt.
Emergent Group/Local Govt.
Emergent Group/Communications
Emergent Group/Social Psychological
Emergent Group/Alienation
Emergent Group/Disorganization

Figure 104 - Major Dyad Functional Interactions and the Scaled Impact of Technological Innovation

++ + 0 - --

○ Old Technology .

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Table 16

SLOPE COEFFICIENTS FOR 10 QUALITY OF LIFE VARIABLES,
ACROSS THREE POST-DISASTER PERIODS*, NEW YORK TIMES, 1972

BETA	B	VARIABLE NAME
.19	.06	EDUCATION
.16	.08	ATTITUDES TOWARD GOVERNMENT
.10	.05	LEISURE AND RECREATION
.09	.03	RACIAL AND MINORITY GROUP RELATIONS
.07	.04	QUALITY OF WORK
-.02	-.01	CRIME
-.05	-.03	ENVIRONMENTAL QUALITY
-.16	-.10	LIVING CONDITIONS
-.31	-.18	TRANSPORTATION
-.37	-.16	HEALTH

*THESE PERIODS ARE: 1--WARNING, THREAT, IMPACT (JUNE 15 - 27),

T1 THRU T13, N = 48

2--RESCUE, INVENTORY (JUNE 16 - JULY 9),

T14 THRU T35, N = 61

3--REMEDY, RECOVERY (JULY 10 - DECEMBER 31),

T36 THRU T200, N = 81

Attitudes Toward Government also were articulated more frequently in the later time interval. Often the intent was to demand that more be done through the public sector to alleviate the suffering in impacted areas. Commentaries on losses to Leisure and Recreation facilities became more frequent as attention moved beyond the immediate needs of salvage and repair. At the negative end of the scale, the expectations of diminishing reverences to Health, Transportation, and to daily living needs were borne out. The center positions are held by quality of life indicators related to Race relations, Work quality, and Crime. This is as much owing to the few references to these categories as it is to their similarity of significance in each of the three aggregate time periods.

18. CONCLUDING REMARKS

What does this content analysis tell us? Caution is in order in interpretation, for it is easy to be drawn into the trap that studies such as this one "prove" something--that they validate a social theory. This would be unwarranted for several reasons. First, our reliance upon a single newspaper introduces the possibility that the editorial policies of New York Times have filtered the data so that what is reported here is editorial policy rather than social reality. Second, the macro-level of analysis used here introduces an unknown amount of aggregate error. This is especially true that references to complaints and the the Federal government may not be interpreted meaningfully in order to assert that these are complaints against Washington. Instead, the article at issue may have reported complaints against a business, only to proceed to praise some Federal agency later in the story. Third, the categories were only encoded as "mentioned" or not. They were not identified as being "favorable" or "unfavorable" comments or as being located along an attitudinal scale. Finally, one cannot "prove" a thesis in studies such as this one, for it would be necessary to examine all possible instances in order to do so. The logic of science is to disprove.

Despite these and other methodological limitations, it is felt that the content analysis reported in this technical paper has not invalidated the fundamental tenets of social action theory that underlie the Total Assessment Profile. Increases in generalized social and psychological costs (and of some few benefits as well) have been seen to accrue across time. Conversely, marked declines have been witnessed in the more immediate and physical costs associated with disasters--precisely the types of categories that exclusively are found in traditional benefit/cost analysis. We feel that these findings make it difficult to contend that "unmeasurable"--i.e., non-financial--costs need not be included in studies of cost effectiveness. Furthermore, it seems untenable that findings taken at one point in time will be equivalent to those assessed at another. As a corollary to this, quite different outcomes are likely to emanate from different spatial analyses as well.

By virtue of the limited nature of this research, these findings can only be regarded as tentative. Yet, they constitute a challenge to traditional benefit/cost approaches. The conclusions reported here can be strengthened only by further study, by using other data gathering methods, and by investigating different social settings. Nevertheless, we feel that the probability of replicating our findings is high.

XVIII. CONCLUDING REMARKS

The traditional benefit-cost analysis is based on a static and exceedingly idealized economic theory ill-fitted to account for a multitude of economic, social and political interactions over time and over space in a political and geographic setting. This static traditional economic theory ignores demographic dynamics, technological progress and institutional changes as well as the various limits to economic activity and its growth induced by various finite natural resources such as space for the "lebensraum" in a world where the various impacts of such changes over time and space seem rather obvious. The Walras-Pareto model and several of its modifications are idealizations growing out of an 18th and 19th century "old economics" which is ill-fitted to portray the 20th and 21st century worlds with global interdependences and interactions in strategic and economic arenas. While the world is still politically divided it is fast becoming economically integrated. The transformations from hunting and pastoral societies to agricultural societies then to technological industrial urban societies is now thought to progress toward a global "super industrial" society with a mesh of superimposed global interdependences of economic, social and political nature. In such a setting the various traditional and basically short-run static micro and macroeconomic models can hardly be expected to serve a useful purpose for policy, strategic and operational considerations and needs. In particular, the traditional welfare economics and benefit-cost analysis do not provide, even philosophically, and adequate, relevant, and meaningful base for economic impact analysis, which clearly must belong to a realm of considerations of economic development over time and space.

Further, economic development should be understood in social, institutional, political and historic perspective with the full understanding that economic development, indeed, deals with open systems rather than with such artificially closed systems as the Walras-Pareto General Equilibrium model. This would suggest that an economic impact evaluation may have to be augmented by social, institutional and political impact evaluations. While traditional micro and macroeconomic theories have often been short-run oriented and highly exchange market oriented, economic development models, in a contrast, attempt to include population, technological and institutional dimensions and their influences on total real economic activity in the long-run.

The long-run effects of fiscal policy and public programs can be expected to be reflected over time and a geographical space not just in a local region, but eventually globally. Such effects cannot be analyzed just in terms of short-run static exchange market mechanisms typically assumed for traditional economic analysis. Besides exchange market effects, public programs can have direct or indirect "exogenous" impacts or "external" effects on political, social, institutional, technological and economic activities not restricted just into a specified region but having eventually also global impacts.

It has been pointed out in the literature that aggregation has certain advantages and disadvantages in economic analysis. One of the disadvantages is that overt aggregation can assume away important economic, institutional, social and political structural effects without which the understanding of the processes of economic development may be exceedingly inadequate. While traditionally macroeconomic theories have been decomposed into inter-industry and interregional input-output models, very little has been done to view the consumers' sector from a structural point of view emphasizing differing social, psychological, economic and political groups with certain spatial or geographic distribution patterns.

It is interesting to note that private sector firms have found the traditional Walras-Pareto Theory of consumer behavior operationally unsuccessful, and have resorted to socioeconomic, cultural, political, psychological, anthropological, etc. studies in order to segment a marketplace for particular products that match particular social groups with their peculiar and measurable characteristics. This, indeed, is an approach recognizing group preferences in terms of operational, empirically measurable characteristics. While political scientists point out similar approaches are also useful in analyzing prospective election results, the public sector benefit-cost analysis has been blind to the practical marketing approach now evolving in the private sector. Since citizens are not a homogeneous group with homogeneous patterns of desires and equal access to social, economic and political activities and, thereby, to society's scarce resources and enjoyment thereof, all public projects must be expected to have respectively different impacts on these different social groups. The traditional micro and macroeconomic theories are ill-fitted to treat such different impacts on the respective different social groups. It appears only sensible to ask a question whether a segmentation of the total citizen's group into some specific social group would yield to the planners and decision makers of public programs an approach for differential impact analysis in a practical operational manner as indicated by the marketing and market segmentation activities of the private sector.

It should be noted that a segmentation of public into specific groups of citizen-consumers is an empirical matter leading potentially to an "input-output" structure of the consumers' sector, interacting -for example- with an input-output structure of the industry. Further, such structures also can be extended into interregional input-output structures. In a contrast to the traditional welfare economics and benefit-cost analysis, all this structural modeling and accounting can be done in a framework of economic development.

The traditional neo-classical economic development theories have not been very successful as policy sciences in the care of the so-called developing or "third" world. A part of the problem seems to relate to institutional, social, political, cultural and historic processes that such models are ill-fitted to portray. This would suggest that these "exogenous" processes cannot, indeed, be ignored in an economic impact analysis; and, more explicitly, socio-political impact analysis should be considered as a necessary complementation of the economic impact analysis. This is

merely an admission that economic development systems remain open to socio-political and institutional aspects of a society not only in a regional but also in a global setting.

It has been suggested that the impacts of public projects can occur in several dimensions many of which cannot be accounted for in terms of the traditional benefit-cost analysis. This in turn suggests that the assessment of the public projects must include all the relevant and important institutional, social and political dimensions affecting and impacting a society outside of the realm of a short-run exchange market oriented economics. An assessment profile for the evaluation of a public project can be expected to consist of factors and measures not necessarily reducible to any meaningful monetary terms. A way of developing a Total Assessment Profile (TAP) for the purposes of evaluating public projects is the subject of this report.

This report provides information that is helpful in creating a more complete benefit-cost picture by shedding light on the potential inputs of several social science disciplines. The major thesis of this approach is that traditional economics, even though it is presumably a social science discipline, provides a highly distorted and unrealistic view of man's social life and of both benefits and costs for implementing new technology. As such, the section begins with a brief review of sociology, anthropology, economics, political science and human geography.

Early in the project it became clear that the economic foundations of the traditional benefit-cost analysis are narrow, and based mainly on concepts of Walras-Pareto microeconomics and its extensions that are inadequate for economic, social and political impact analysis. Hence, we discuss the notion of "systems" as a basis for integrating the various interdisciplinary inputs into a theoretical framework for determining both benefits and costs. Many of the classic systems theorists and their contributions are discussed in detail in order to provide insight into the important dynamics of the social system. Man as a social psychological system is also discussed. The synthesis of these various systems views provides a basis for aggregating people into meaningful human groups based on their relative organization of and ability to participate in the institutions of the larger social system. These aggregate social groups are called social psychological phenotypes and are felt to provide a more accurate insight into the potential benefits and costs than the more popularly used socio-economic-status indicators. Social scientists have traditionally used these latter indicators because they are easy to determine and the scientific procedures for refinement of the phenotype notion had not been developed.

In the new procedure social space is used as a basis for clustering people with similar social and demographic backgrounds. Since people with similar social backgrounds, ability to participate in the goods and services of the society, values, and perceptual/attitudinal and motivational characteristics, tend to share common living areas, the new technology proposes utilizing this information for determining the location and relative size of various human groups.

In traditional benefit cost methodologies socio-economic status provides the only basis for human grouping and little if any attempt is made to ascertain anything about a technological innovation except how it will affect the monetary well being of each socio-economic stratum. The proposed technique stresses the dynamics of integrating people into an ongoing social system. The theory that provides such insight is called "social action theory". This theory explains the basic elements involved in man's relationship to the social system and the relationship between these elements. Four primary elements are discussed including values, norms, mobilization of motivation, and situational facilities. The relationship between these elements is of great importance for understanding human social life. That is, there exists a hierarchical relationship with values in the uppermost position and situational facilities in the lowest position. If one changes any aspect of a higher element, change is automatically introduced in a lower level element. However, the reverse is not necessarily the same. That is one can affect the motivational aspects of a human group without necessarily affecting the values of that group.

Utilizing this theory the Total Assessment Profile focuses on the value structure of the phenotypic groups involved. A cross impact values matrix is created in order to assess the relative impact of a new technological innovation on the phenotypic groupings. Since the average citizen cannot be expected to know the intricacies of a technological innovation or potential impact on values, the technologies sponsor is asked to evaluate the technology in light of selected values for ascertaining the perceived potential impact on those values. A preference ranking of values provides the input of the various phenotypes. Since it is possible to optimize on a value which is utilitarian for a particular group in the short-run situation but detrimental to them over the long range, a system of weights based on Maslow's hierarchy of human needs is introduced as a control to provide a system of weights which ultimately provides the decision-maker with this information. The output of the matrix is a relative values impact statement for each social psychological phenotypic grouping. The relative size of each phenotype in the population is also given so the decision maker can know in advance of the potential impact (benefit or cost) for the total society.

Considerable attention is given the treatment of social groupings in the area of hazard perception and marketing. While no one discipline nor group of researchers has suggested the technique for ascertaining the social psychological phenotypes, both these areas have progressed along similar lines.

The original problem which prompted the creation of the present procedure including the underlying theoretical substructure concerned assessment of the benefits and costs associated with an early warning disaster satellite. Early in the project much of the proposed investigation was found to be politically non feasible. As such, the research team attempted to validate the theoretical underpinnings of the present endeavor by performing a content analysis of press reports of the dynamics of the disaster.

Even though the paper selected was physically quite removed from the impacted area reports suggested that the dynamics of adjustment originally hypothesized were operative and that procedure with a new technology was warranted. This content analytic view comprises the final aspects of the project.